

Beneath are similar red argillites which lower down become more light colored and speckled and contain more or less mica. Under them a large belt of jasper banded, ore bearing rock is developed which forms on the north edge of the hill high bluffs. Then follows a narrow swamp valley and the other side of it is granite.

From here went to the Hecla Mining location of Breitung which is in the north half of the N E $\frac{1}{4}$ of Sec. 8. There a similar succession of beds is noticeable but the strata are much more disturbed and broken up, to a great extent also covered with Silurian sandstone. In a diamond drill hole first some narrow seams of blue ore was struck, beneath which red and red and white speckled micaceous argillites are found to a depth of 180 feet. The top layers are formed by 73 feet of Silurian sandstone.

Thence we went to the Menominee Mining Co. explorations on the west line of Sec. 9 in the N.W. $\frac{1}{4}$ of the N.E. $\frac{1}{4}$, there after going through about 14 feet of drift and some Silurian sandrock a seven feet thick belt of blue ore was struck with some seams of jaspery mixed ore. Under it red argillites as in Woods mine and below a white and red speckled argillite mixed with quartz grains and occasional bands of compact glassy quartzite. This stratum continues to the bottom of the shaft which is about 60 feet deep went from here to Breitung's location and followed the road down hill.
base

At the close to the swamp some greenish quartzose micaceous schists crop out. Across the swamp are close by granite knobs. Went along the road to Felch passing over the north line of Sec. 8. Came by the limestone outcrops in S.W. $\frac{1}{4}$ of Sec. 33, T. 42, R. 28. Thence turned west and came by a newly made road to the village Metropolitan which is in the S.E. $\frac{1}{4}$ of the N.E. $\frac{1}{4}$ of Sec. 32, T. 42, R. 28.

Stopped at hotel in the village of Theodore. After supper went to newly discovered mine in S E $\frac{1}{4}$ of the N.W. $\frac{1}{4}$ of Sec. 32. Detailed description of observation to be given after another examination of the localities tomorrow.

Thursday June 22. Went to Northwestern Mine. Crossed the ore bearing rock belt and examined the limestone hill south of it. It is a direct continuation of the limestone outcrops of the Metropolitan property. Some testpits at the base of the hill plainly exhibit a dipping of the ore bearing rocks under the limestone.

The limestone on the eastern localities is divided into 4 separate ranges and between each of them the ore formation comes to the surface superficially much shattered, deeper in regular stratification. It is from this fact evinced that the limestone is a younger rock than the ore formation. It lies in scattered masses on it. Another proof of the younger age of the limestone is furnished by a drill hole on the Metropolitan mine. North of the great quartzite belt about 200 steps or more the limestone appears to be underlaid by ferruginous argillaceous mica schists and then only succeeds the quartzose part of the iron bearing series. However also in these micaceous argillites plenty of quartz grains are intermingled besides seams of glassy quartz.

Diagram

It is not positively ascertained whether the very large series of quartzose and argillitic mica schists found on the north and south side of the Felch mountain ore formation are really the immediate substratum of the limestone formation as similar mica schists occur, likewise associated with the productive ore belts in Sec. 8. but there is no limestone observed and the schists are apparently beneath the ore which dip south.

Went also to the explorations in S.E. $\frac{1}{4}$ of Sec. 33, T. 42, R. 28 where a diamond drill has been used for exploration but no new facts came to light. Formation strikes from N.W. to S.E. Dips N.E.

Diagram

Friday June 23. Left Felch Mountain to return by the Bad Water road. Passed Sec. 31 without seeing anything, likewise in Sec. 36, T. 42, R. 29. We kept on the sandstone capped high plateau. Descending down to the Sturgeon river quartzites come to the surface. After crossing the river we find a camp in S.E. $\frac{1}{4}$ of N.W. $\frac{1}{4}$ of Sec. 35. North of it is a small creek bordered on the south side by bluffs of Silurian sandstone. On the north side of the creek is a low rounded elevation which consists of a belt of Huron limestone dipping south. The limestone is overlaid by red micaceous argillite and by quartzose mica schist. Below the limestone are also quartzose mica schists cropping out and further north about 200 steps north of the limestone is a similar small ridge consisting of granite ledges.

We go from here on. Find testpits in S.W. $\frac{1}{4}$ of N.E. $\frac{1}{4}$ of Sec. 23, T. 42, R. 29. Strata dip south but almost vertical. On south side are ferruginous mica schists. Further to the north grey quartzites with slaty seams, then red jasper banded ferruginous rocks with some ore seams of small thickness.

Thence go to Woods camp on west line of Sec. 32. At the creek they had a diamond drill boring south 270 feet through quartzite and mica schists principally. They supposed to strike a slate ore seam visible in the quartzites in testpits but the drill did not hit it.

From here went on to camp in N.W. $\frac{1}{4}$ of S.E. $\frac{1}{4}$ of 31. Took dinner there. The before observed outcrops of limestone on the former McMinns option are close to the north side of the camping ground. The limestone is evidently a large loose mass resting on the mixed jaspery ore formation exhibited in the surrounding testpits.

After dinner went to the shaft sunk north of McMinns deep shaft on the road where a very fine soft blue ore is mixed with alternate seams of a calcareous and argillitic or also partly silicious rock richly impregnated with martite. It is evident here how the seams of pure ore were formed by gradual lixiviation of the silicious and calcareous material from the banded rock mass. This rich orebearing mass could very easily be freed from the lighter rock substance by stamping and washing as the rock is quite soft and crushed without difficulty. North of the shaft are the hard banded jaspery lean ores.

As on former occasions stated, south of these pits hematitic mica schists and argillites form a very broad belt. By going north over the crest of the hill we find its summit overlaid by Silurian sandstone and limestone. But descending the northern slope we find in the north part of the section again the hematitic mica schists and argillites in great force. Just the same as on the south side also the belt of soft blue ore mixed with narrow bands of rock is found in a position next to the banded jaspery lean ores. It is therefore to be surmised that we have here a large fold before us with the ore formation in the centre and the higher micaceous argillitic beds covering them on both. Further on unto the west end of Sec. 36 the same rock series continues.

Diagram

In several places the limestone is found in outcrops which in a few instances are evidently huge masses detached from the main body of layers and reposing on the surface of the ore formation. The outcrops of a quite quartzose ferruginous mica schist and of a very large belt of quartzite on the south side of it are particularly fine in the S W. $\frac{1}{4}$ of Sec. 36. North of them is the ore formation but nowhere a large body of pure ore has been found. Returned to Quinnesec Friday evening.

Saturday June 24. Rain in the morning. Packed specimens. Wrapping paper 20 cts. Box 15 cts. 2 horses and wagon for the trip to Felch Mountain 3 days \$15.00.

I learn from the man which drilled the hole on the Metropolitan property that he bored south through the almost vertical ledges under an angle of 70 degrees. Found first mica schists 75 feet, then through marble 125 feet when he stopped the drill in marble. I found at the drill hole a large number of cores of a dark diorite-like rock which as the man said were carried there by Corry in order to deceive persons regarding the results of the boring. These occurred in a drill hole of an altogether different locality.

Sunday June 25. Had to remain as no train went.

Monday 26. To Marquette. Paid at land office for maps \$20.00

Tuesday 27. To Negaunee.

Wednesday 28. At noon to Escanaba and Crystal Falls to go with Stegmuller and Brotherton to Sec. T. 44, R. 37. Wrote home. Name of the student is Weber of Detroit. N B. Aug. 2. promised to be with Breitung at Duluth.

Thursday 29. From Florence to Crystal Falls and thence by trail to Brothertons exploration, a distance of about 12 miles. Crossed Michigamme river at the Falls near S.E. corner of Sec. 7, T 43, R. 31, thence to S.E. $\frac{1}{4}$ of Sec. 33, T. 44, R. 31. The Falls are formed by masses of diorite of mostly fine aphanitic grain and closely merged with well laminated dioritic schist. These rocks occupy there a large surface.

In the S.E. $\frac{1}{4}$ of Sec. 33, T. 44, R. 31 a large hill is formed of the iron bearing rock series in an almost vertical position. South of this hill another parallel hill is formed of a schistose limestone which seems to overlie the ore formation. Separated from it be argillitic or hard hydromicaceous rather light-colored schists.

The large bulk of the iron formation is formed by a succession of quartzite ledges amounting to 3 or 400 feet in thickness and impregnated with some specular grains of iron oxyd. North of it the strata are more schistose, still also principally quartzose and much richer in iron, constituting lean iron ores which sometimes contain streaks of high graded ore. From there further north the light colored and hydro-micaceous argillitic schists are seen exposed which appear to underlie the ore formation but resemble perfectly those on the other side of the hill which seem to overlie it.

In one place a mass of dioritic rock appears to form the substratum of the high cliffs of the quartzite of the iron formation.

And next to this place bulky schistose rock masses project which are in part a porphyritic imperfectly crystalline granitic rock mass. In part plainly exhibit the structure of the before described hydro-micaceous-novaculitic schists in a hardened metamorphosed sub-crystalline condition.

Friday June 30. All through the night rain. Rain also in the morning. Went to testpits in N.W. $\frac{1}{4}$ of Sec. 34. T. 44, R. 31. On the side of trail close north of camp passed a low ridge of dioritic schists running parallel with the ore formation South of the camp. In the testpits the formation strikes north and south. Dip almost vertical.

On east side in pits a micaceous red argillite of various grain and hardness. Next to it a quartzite belt full of concretionary masses of a silicious iron ore but not in quantities promising to be valuable. Next west of them micaceous argillites again. Then a very large quartzite belt of light whitish or red mottled color. Further west are hydro-micaceous schistose rocks which seem to represent the limestone formation. There is a great quantity of quartz in its composition. With this rock occurs also a hard dark colored rock of chloritic-hydro-micaceous and quartzose character which seems to be a lower stratum merging with the dioritic rocks. On a part of the ground the ledges of the different formations are only little covered with drift. In others about 6 or 10 feet of Silurian sandstone lies over them which contain very many cylindrical segregations. (Scolithus). (N.B. The rock specimens of Sec. 34 are by mistake labeled N E $\frac{1}{4}$ instead of north half of N.W. $\frac{1}{4}$).

Afternoon went to outcrops of limestone on Michigamme river in Sec. 28 and Sec. 32 as marked on the map. Also on the way in in S.E. $\frac{1}{4}$ of Sec. 32 and N W $\frac{1}{4}$ of 32 other outcrops of limestone are seen. Otherwise the surface is covered with drift.

Saturday July 1. Returned to Crystal Falls. At the Falls on Menominee and for some distance either way on the trail, large outcrops of diorite. The diorite is quite fine grained and merges with dioritic schists. Some of the massive diorites exhibit a regularly banded stratified structure by alternation of the dioritic rock substance with quartz bands which is to me an evidence of the metamorphic nature of these diorites. See specimens. Returned to Florence. Took dinner and went on to Escanaba that evening.

Sunday July 2. At Escanaba.

Monday July 3. To Marquette.

Tuesday July 4. Afternoon to Ishpeming and return to Marquette. Had an interview with Capt. Sedgewick about the best mode to travel over the Black River district in which he has been exploring.

Wednesday July 5. Received letter from home. Answered. Went to knob on Whetstone Creek. Observed the nodular concretionary structure of the diorites there intermingled with reticulated seams of schists and of crystalline limerock seams, besides quartzose chalcedonic and epidotic seams. The once semi-liquid condition of the diorite and its genetic relationship with the schists is most evident.

Diagram

Afternoon went to LeAnse, thence to Houghton, traveling expenses \$2.00.

Thursday July 6. Went to Quincy mine. Saw Mr. Emmerson the engineer and Mr. Klockner, head clerk. Went over the mine which is now in its lower levels 1700 feet below the surface. Ore bearing amygdaloid rock averages about 7 feet in thickness. Dip of strata about 50 degrees to the westward. A large belt of melaphyr forms the hanging wall. West of that no outcrops for about $\frac{1}{2}$ a mile.

Then in the bed of a creek outcrops of a large series of thin bedded argillaceous sandrocks partly in an easily decaying clayrock condition, partly in ledges of sandrock structure with much of red feldspar intermingled. The thickness of this series is over 1000 feet and its dip is not over 30 degrees but conformable with the other copper bearing rock ledges.

Returning along the Calumet railroad I noticed an amygdaloid belt exposed near the road which was succeeded eastward by a large belt of conglomerate inclosing large boulders of porphyry. Rain all afternoon.

Friday July 7. Rain all forenoon. Went to Portage mines. An amygdaloid vein in melaphyr, quite rich in copper, analcim and prehnite of common occurrence. Afternoon followed the road to Atlantic Stamp Mill. Near bridge a very large belt of melaphyr. Further west an epidotic brecciated amygdaloid in a decomposed brittle condition. Then a conglomerate then melaphyr again with amygdaloid belt. At the Soap and Candle Factory several other amygdaloid belts. Further on near the brewery another conglomerate belt and then again melaphyr.

From Stamp Mills of the Atlantic went with railroad to the mine but saw only the hoisted rock which is a fine grained greenish grey melaphyr with amygdaloid masses. The amygdules often laumonite or calcspar coated with copper. The vein rock is in its totality very poor but is all stamped and yields about $\frac{3}{4}$ of a percent copper. Stamp mill with 4 large stamps and a splendid washing apparatus.

Saturday July 8. By railroad to Calumet. 65 cts. By stage to Delaware mine \$2.50 in a 2 horse stage carrying 19 passengers besides baggage. Several times broke down. At Delaware mine stopped for an hour. Walked over the mining locality. Old pits were worked once in an amygdaloid trap which contains seams of calcspar and prehnite in abundance. The mines presently worked are opened above this horizon in a belt of conglomerate about 20 feet wide. The footwall of it (the before mentioned amygdaloid) is melaphyr. Its hanging wall is the so-called greenstone, high cliffs of which crown the hill top.

Diagram

The conglomerate of the Delaware mine is generally not rich in copper but it is said the miners hit sometimes on very rich masses. It was a surprise to me to find in the cement of the conglomerate so little copper, but to see in the porphyritic and melaphyr pebbles of the conglomerate, copper leaflets and nodules inclosed.

Went with mail carrier wagon to Copper Harbor. By following the road from Delaware mine to Copper Harbor the cupriferous conglomerate is for some distance cropping out on a level with the road, while above and below massive melaphyrs are exposed. Various old mining locations are passed by the road but about a mile or more this side of Copper Harbor big hills of conglomerate rise and extend up to the Lake shore, the thickness of this conglomerate belt is several thousand feet.

Sunday July 9. Learned from Capt Hotson of the Delaware that the ore bearing conglomerate contains most of its copper in the cementing mass. Further he states that the old diggings were following a transverse fissure vein of calcareo-quartzose and prehnitic character. Several other mines as for instance the Resolute and Clark mines are also fissure veins, likewise the Central mine is a fissure mine.

Visited Mr. LeVeaux the agent of the Clark mine and of the Manganese mine. He drove us out first to Manganese mine about $\frac{1}{2}$ a mile south of his dwelling which is on the plateau of a conglomerate ridge. South of the conglomerate follows a belt of melaphyr of partly amygdaloid character under which the manganese ore associated with calcspar forms a belt of from 2 to 4 feet in width. The footwall of the ore is likewise a melaphyr belt of great thickness. Dip of the beds north under an angle of 50 degrees.

From this place drove half a mile south to the abandoned Clark mine, a fissure vein intersecting the melaphyr and the diabase which forms a distinct range south of the melaphyr belt. The vein matter is quartz and in part prehnite. Copper is not very abundant in it. The walls of the vein are formed by a more or less coarsely crystalline diabase which by exposure readily decomposed after the lapse of a few years. Drove from the mine back to the harbor after stopping with Mr. LeVeaux for a while.

Then to the Old Fort where a fissure vein of black oxyd of copper has been discovered, cutting across the conglomerate and extending into the lake. A large amount of copper ore is said to have been taken from the old pits now filled with water and rubbish but no particle of the ore or sign of such a vein extending into the lake is at the present noticeable.

At the south shore of the harbor the melaphyr forms several prominent rows of cliffs which are of an amygdaloid character by abundantly disseminated nodules of delessite. The other portion of the shore is formed by the conglomerate underlying it. This conglomerate belt is nearly a mile in width.

Diagram

Monday June 10. Returned per wagon to Delaware mine \$1.50. The conglomerate is overlaid by a hard diabase. Underlying is an amygdaloid trap in which formerly a fissure vein was mined.

Diagram Central Mine.

Page of German

Tuesday July 11. To Phoenix Mine. A fissure vein like the Central mine connected rock about the same as in former. From here to Cliff mine likewise a fissure vein. Little work done there. Saw in the rock house some mass copper and a stamp rock similar or identical with that of the Phoenix mine. The top of the bluffs is formed of a dark blackish diabase. Further back massive diabase of a more perfect crystalline texture succeeds in a very broad belt from the height of which the country slopes down westward to Lake Superior which is about 2 miles distant. I notice west of the diabase not far from the lake shore a mining pit but have to inquire of Mr. Brockway agent of the Cliff mine about the nature of the rocks in that place.

Bought from a dealer in specimens 1 small specimen of apophyllite from Phoenix mine and 1 specimen of natrolite from St. Clair mine for 50 cts. The before mentioned abandoned mine near the lake shore is likewise opened in a fissure vein of which is uncertain whether is it a continuation of the Cliff mine. In its lowest level Cliff mine is about 1300 feet below surface.

In the afternoon went with Agent Brockway along the cliffs observing several surface indications of other fissure veins, all of which carry some copper and consist of the same silicio-calcareous mother rock as in the larger productive veins.

Ascended the bluffs. In following one of the veins vertically to edge of the top plateau where it becomes hidden under the soil. On one of the knobs consisting of a quite coarsely crystalline diabase is a splendid panorama view. North of this coarse diabase belt which has a great width I am informed succeeds an amygdaloid melaphyr called the Ash bed which is considered quite productive in copper. Mr. Brockway drove me in the evening after supper over to Eagle River where I met Mr. Hill which explores in this so-called ash bed on north side of the diabase, and from specimens shown to me it appears he found a very productive copper bearing belt. A dark reddish brown amygdaloid is the mother rock.

On the road to Eagle River village the succession of the different rock belts is nicely to be observed. Commencing at the Phoenix mine we have on the level of the valley melaphyr and amygdaloid rock. Next above we should expect the conglomerate belt of the Delaware mine but it is said to be missing. However in the waste rock one can observe scattered conglomerate blocks. Above follows a dark blackish diabase which on weathered surfaces becomes light grey and is dotted with globular concretions, which concretionary structure becomes still more conspicuous if the rock further suffers decomposition and disintegrates into little balls from the size of a pea to that of a hazelnut.

Above this lower rock follows the before mentioned coarsely crystalline diabase which when it begins to decompose likewise exhibits this globular concretionary structure. Further on follows a broad belt of melaphyr and amygdaloid trap in which some mining has been done until at Eagle River village the river falls over the melaphyr and cuts through a large succession of conglomerate beds ere it enters the lake. The conglomerate is seen in close contact reposing on the melaphyr at the Fall. This conglomerate is identical with the large conglomerate belt of Copper Harbor.

Wednesday July 12. Went with Mr. Brockway to the south part of the Cliff mine location where he is exploring the ground with a diamond drill but has so far not discovered any valuable rock bed. The cores are melaphyr and contained in some instances a few thin leaflets of copper. The borings were continued to a depth of about 400 feet and the object was to find the second conglomerate belt of the Central mine but so far without success. Thence with stage to Allouez mine.

Visited Agent Smith which received me very politely and invited me to stay at his house which I accepted. Went over the mine which is opened in a 20 feet wide conglomerate belt corresponding to the Delaware conglomerate and carries considerable copper. Above the conglomerate follows a large body of melaphyr the lower belts of which have a bird's eye structure, and resembles the lower greenstone beds of the Cliff mines to a certain extent.

Further on follows a fine grained almost aphanitic melaphyr which merges with an amygdaloid belt containing some copper. Further on is a large body of ordinary melaphyr. At the stamp mill $\frac{1}{2}$ a mile further across the strike of the formation the large conglomerate belt of the Copper Harbor series outcrops. As underlying rock of the Allouez conglomerate we find again melaphyr partly amygdaloid in structure.

According to measurements on the Kearsarge Mining property the Calumet and Hecla conglomerate should be found 2050 feet east of the Allouez conglomerate but is not discovered. The conglomerate belt of the Seneca mine or Ahmeek mine is according to measurements 3100 feet east of the Allouez conglomerate. The amygdaloid belt of the Kearsarge mine is 1250 feet east of the Seneca conglomerate.

After dinner went to Seneca or Ahmeek mine. This conglomerate is composed of only small almost equally large pebbles and has a partially chloritic green cement. It is in dark patches very rich in coarse copper. But other portions contain very little of it. Its thickness is 60 feet. In the hanging is a dark blackish melaphyr. As a footwall a grey compact amygdaloid trap occurs. With the conglomerate occurs some fine grained argillaceous sandrock beds.

Thursday July 13. Went to Wolverine mine which lately has been opened in an amygdaloid belt very rich in copper as far as the present progress of the work shows. From there passed by the Schoolcraft mine, a part of which, probably the older shafts are sunk in a reddish amygdaloid filled with rather large amygdules and seams of white calcspar which carries coarse lumps of copper but does not seem to be very rich. Another part works the conglomerate belt but I did not see any of the stamp rock, merely the large waste rock piles. The conglomerate fully resembles the conglomerate of the Calumet mine.

From here to Calumet. Took dinner at Calumet Hotel. At Calumet mine went over the rock houses and machine shops which latter are of an enormous size and beautifully executed. With the conglomerate some of the melaphyr on the hanging wall is hoisted which contains in places a large amount of copper in sheets filling out narrow fissures and in fine granular particles distributed abundantly through the rock. Returned in the evening to Houghton. Railroad fare 65 cts. Box of specimens ,30 cts freight to Hancock.

Friday July 14. Packed specimens. Saw Mr. W. Edwards cabinet of Lake Superior minerals. It contains some most excellent specimens of calcspar with copper, crystalline copper and silver in large masses, also prehnite, apophyllite and analcim are very fine. Intend also to see the cabinet of Mr. James Walls in Hancock, who is said to have a specimen of calcspar with copper from the Phoenix mine for which he paid \$90.00. Made arrangements with Mr. Gillis to depart with him on Monday for Lake A-go-ge-bic.

Afternoon to Huron mine. Collected some specimens containing a peculiar sulphuret of copper of black color and obtained from the Capt. a piece of datolithe found there quite frequently.

Saturday July 15. Hired a livery team to visit Oseeola, Calumet and other mines in that vicinity in company with Mr. Ames. Capt. Daniels of Osceola mine also agent the Ahmeek mine and the Tamarack mine, a most liberal and well informed gentleman.

The Osceola mine is in part worked in the Calumet and Hecla conglomerate but most of the productive rock has been taken out. About 3 or 400 feet east of the conglomerate is an amygdaloid belt very rich in copper which is principally worked at present. There are abundant specimens of crystallized and native datolith of prehnite and of fine stilbite to be collected and the captain gave me of them very fine specimens. He has a most wonderful collection of Lake Superior and New Mexico specimens besides some from European localities. All those specimens are in crystals of great beauty and perfection.

Before we came to the Osceola we went through the rockhouse of the Albany and Boston mine, now called Ohio mine. The conglomerate there is very coarse but locally contains considerable copper and in some of the cupriferous conglomerates the copper is transformed into green silicate of copper and into red oxyd which sparingly occurs in fine bright red crystals. Also leaflets of silver are not rare in the rock. This conglomerate is said to be a different belt from that of the Calumet mine, occupying a lower position.

From the Osceola went to Calumet with the intention to see the drift cross-cutting 1500 feet of the formation and begun in a shaft near the superintendents house. It cuts through melaphyr and amygdaloid belts alternating 3 times. The amygdaloid carries some copper. We could not go underground at this time of the day and no rock is hoisted from that part. I therefore had to rely only on what Capt. Willis told me. Afterward met Capt. Huston which is specially superintending this work. Returned to Houghton. Buggy \$3.00. Expense for horse and driver \$1.50.

Sunday July 16. Remained at Houghton. Visited Sheldon and Columbia and Portage mine locations but did not see anything new.

Monday July 17. Went over Quincy, Pewabik and Franklin mines. 6 days board Monday evening.

Tuesday July 18. Went with stage to Rockland. Fare \$6.00.

Wednesday to Ridge, Adventure and Mass mines. \$1.00 fare, 1 axe \$1.25, paper cups 25 cts/ Hired a man at \$2.00 per day through Mr. Gillis. At the Ridge well entertained by Capt. Harris. At the Mass mine by Capt. Cheneaux. Got specimen of datolith there with inclosed copper.

Thursday July 20. With wagon to Fergusons at the location of the Windsor and close to the Norwich mine. Wagon my share, \$10.00 for the whole trip to Lake Gogebic. The first mine we passed beyond Rockland is the Forest mine across Ontonagon River. It is an epidotic amygdaloid quite rich in stamp copper. But the mine is not worked now.

Short distance beyond it on the roadside a conglomerate belt crops out. Further on no exposure of interest was seen but several old mining locations are on the way. On the road and the mining location east of it are very high precipitous trap bluffs at the base of which the mines were opened. The copper bearing vein consists of a very hard epidote which contained nests of mass copper but is otherwise very poor in metal.

Friday July 21. Started after breakfast for Lake Gogebic. Wagon \$10.00. Stayed over night at Fergusons, paid \$3.00 for me and my man. Arrived at landing at 6 o'clock in the evening. Camped there.

Saturday July 22. Walked up to Gillis camp in S.W. $\frac{1}{4}$ of Sec. 14, T. 47, R. 43. Left trail near $\frac{1}{4}$ post of N. line of Sec. 24. Went south. Found the bluffs composed of an altered granite like quartzite and of an overlying conglomerate inclosing rounded granite pebbles. This conglomerate and the quartzite contain seams of galena. Dip of formation to the north. Further on these bluffs continue along the south side of the trail. Not far from the camp are high rock bluffs consisting of a dioritic schist with inclosed massive diorite of fine grain. A part of this schist series which is over 150 feet in thickness consists of a breccia or conglomerate somewhat resembling the quartzite conglomerate but not exactly alike it.

At the camp near the house the quartzite conglomerate crops out. It contains much iron pyrites. Dips north. Evidently overlying it is the galena bearing quartzite. Part of it is granular, part of it flinty and of gray color, but a belt of granular quartzite next underlying the productive ore belt is of light red color and weathers into a porous dark ferruginous sandrock mass. The galena is occupying narrow seams or nests parallel with the formation and is to be found scattered through the rock through a thickness of 70 or 80 feet.

North of it is a black graphitic schist interlaminated with quartz schist or calcareous fine grained and banded or laminated quartzite which weathers rusty brown from intermixture of carbonate of iron. These beds continue to the bed of the creek which flows into the Presque Isle River.

North of the creek are high bluffs of a fine grained black slate rock which is in part harder and more quartzose. The thickness of this slate belt is about 500 feet or more. Going north over the bluffs we descend into a depression and after crossing this space where no outcrops are seen a high ridge of melaphyr rises to an elevation of about 200 feet. This trap is partly fine grained, very dark. Sometimes it incloses amygdules of spar, of epidote, delessite and red feldspar. The upper layers inclose large feldspar crystals in great abundance. Copper very scarce or usually absent. A part of the melaphyr is pervaded with streaky irregular masses of an aphanitic lava in which distinct lines indicate its former fluid condition. This trap range extends parallel with the quartzite and slate formation across the south part of the north half of Sec. 14 and 15.

Sunday July 23. Went over the bluffs in N.W. $\frac{1}{4}$ of N.W. $\frac{1}{4}$ of Sec. 23, T. 47, R. 43. The schists are in part brecciated. The fragments cemented by the schistose substance are a fine grained greenstone. From here went southeast and came to other schistose and dioritic outcrops. Further south granite belts intersect the schists and diorites and massive diorite much prevails over the schistose portions. Some of the diorite is coarsely crystalline and contains red feldspar and probably also quartz. From near the south line of Sec. 23 turned west and then north towards the camp but outcrops are scarcely seen and are in that case diorite with granite. S. $\frac{1}{2}$ of S.E. $\frac{1}{4}$ of Sec. 15 large loose blocks of banded lean ore in bed of creek.

Diagram. Sec. from N. to S. at Gillis Lead Mine.

Monday July 24. Left Gillis camp at 7. Went along trail across Presque Isle River, noticed on the way several outcrops of the galeniferous quartzite. The black shales are higher up on the hillsides north. At Presque Isle lower down than we crossed it is the black quartzose slate rock exposed in the bed of river.

In the bed of creek on S.E. $\frac{1}{4}$ of Sec. 18, T. 47, R. 43 an abundance of angular blocks of a lean quartzose iron ore and no doubt can exist of the rock in place nearby. From here to S E corner of Sec. 13 in the next township where large bluffs of diorite are on the south side of trail which continue for quite a distance along trail.

The diorite is fine grained, full of quartz and calcspar veins and much of epidote. It has a sort of brecciated character. Large diorite outcrops near the $\frac{1}{4}$ post on north line of Sec. 23. All the diorite is very fine grained and a part brecciated. 560 steps south of quarter post other high bluffs of a much brecciated diorite belt, several 100 feet wide. This same brecciated diorites form also high bluffs overlooking all the surrounding country.

In the N.W. $\frac{1}{4}$ of the N.W. $\frac{1}{4}$ of Sec. 23, T. 47, R. 44. Descended to Little Presque Isle river and encamped in the S.E. $\frac{1}{4}$ of the S.E. $\frac{1}{4}$ of Sec. 15.

Tuesday July 25. Thunderstorm and rain, At night. Left camp in the morning at 7. First outcrop we saw in S.E. $\frac{1}{4}$ of Sec. 17, not far from section line. Then found the high limestone bluff, Dip N.W., near west line of Section 17, Near centerline of S.W. $\frac{1}{4}$. Again an outcrop of quartzite in centre of Sec. 18. From here diagonally across north half of Sec. 13, T. 47, R. 45 to Mr. Gillis camp in S.W. $\frac{1}{4}$ of S.W. $\frac{1}{4}$ of Sec. 11.

The creeks on map are falsely marked. North of camp 1200 from south line a strong magnetic attraction. On testpits sunk there a black magnetic schist found containing about 15 or 20 per cent of magnetite. Dip north. Close north of it a diabase rock is found in the pits and higher up the hill large rock walls of partly amygdaloid trap are exposed. South of the magnetic schist no strata have been uncovered but a high hill on which the S.W. section corner of Sec. 11 is situated consists of quartzite.

Wednesday July 26. Went to Fays pits in N.W. $\frac{1}{4}$ of S.W. $\frac{1}{4}$ of Sec. 10 and to the adjoining Gillis pits in the N.E. $\frac{1}{4}$ of S.E. $\frac{1}{4}$ of Sec. 9, T. 47, R. 45. A belt of banded jaspery iron ore about 500 feet wide and dipping north forms the basal part of the hill slope. The strata lowest down dip under an angle of about 30 degrees. Those furthest north are vertical and close to them only separated by a narrow belt of brown sandy quartzite commence high bluffs of trap, partly fine grained, partly amygdaloid or also porphyritic by dispersed large crystals of feldspar. The ore bearing rocks dip decidedly under the trap in apparent conformity as regards the strike but I do not consider them conformable. The brown sandrock seems to be a portion of the trapean formation.

In the ore formation are some narrow seams of a good soft hematite but as a general thing the iron ore is so mixed with quartz seams that as far as the testpits exhibit it no prospects for a large deposit of clean ore can be had. South of the pits is a swamp and very deep drift covers the strata.

On the south side of this swamp rises a row of high bluffs formed of a very thick series of flaggy fine grained and iron colored quartzites interlaminated with argillitic clates regularly dipping north, Outcrops on north and south side of this hill range. Under this flaggy and slaty series 6 to 8 hundred feet in thickness is a belt of flinty quartzite breccia and further south this is underlaid by a white fine grained quartzite.

On my first trip to Sunday Lake I saw only these flaggy and slaty quartzites and had not observed the overlying ore bearing rocks $\frac{1}{4}$ of a mile further north, between them and the trap range. See specimens. Sketch of Sec. N. and S. across the centre of Southwest $\frac{1}{4}$ of Sec. 10, T. 47, R. 45. follows.

Diagram

Thursday July 27. Night dark. Rain. Left Gillis camp in Sec. 11. Went to Sunday Lake, crossed it with canoe and proceeded after landing to Moores explorations in S.E. $\frac{1}{4}$ of Sec. 7. A large range noted on the map as consisting of iron ore consists of a dark ferruginous schist more or less magnetic. Some layers are more slaty, others more massive and argillitic and quartzose. The thickness of this series is several hundred feet. It dips approximately north. On the north side it is overlaid by ferruginous quartzite which in the still higher ledges becomes richer in iron and constitutes a banded jaspery lean ore amounting to a belt of 4 or 500 feet in thickness. Further north the land sinks into a valley beyond which a trap range rises.

Diagram

Went to Harpers testpits in S.W. $\frac{1}{4}$ of N.W. $\frac{1}{4}$ of 13, formation strikes E. and W., dips north. 150 steps south of camp a large granite bluff. From camp northward a very large series of ferruginous quartz schists totally different from the iron rocks previously seen. The ore is a grape ore mixed in bunches with the quartz. Further north is a black graphitic rock containing much iron. It is connected with argillaceous-quartzose flagstones of various lighter or darker colors. The series is very thick and has most resemblance with the Commonwealth ore formation.

Went from here along trail to Piece's camp in N.W. $\frac{1}{4}$ of N.E. $\frac{1}{4}$ of Sec. 15, T. 47, R. 46. The pits are on the north slope of a high hill from which a splendid view northward on Black River valley and the Trap Ranges is to be had. The ore formation is the same as in Sec. 13. South is granite, about $\frac{1}{6}$ th of a mile from the pits, of which some are situated in the northeast corner of the N.W. $\frac{1}{4}$ of 15. Others are near the quarterpost.

In an old windfall the ore is partly hematitic and of metallic lustre, partly very fine crystalline limonite or grape ore and goethite (gothite). It occurs in 4 or 5 different belts of a width from 4 feet to others 18 feet wide. The ore is very rich, clean of the inclosing rock, which is a hard quartzite. The footwall is also a hard quartzite from 20 to 30 feet in thickness. The ore belt strikes from N.E. to S.W. with a northern dip. North of the ore bearing quartzite ledges are other quartzite beds and flaggy argillites tinted with iron. The series of rocks containing the iron is very thick for which reason it is difficult to enumerate the succession of beds in detail.

The ore in the pits near $\frac{1}{4}$ post and those nearer to the camp is supposed to represent the same horizon approximately. West from the pits in 15 is a belt of soft hematite uncovered in a row of testpits by Capt. Piece. The position of the pits is near the south line of the S.E. $\frac{1}{4}$ of the N.E. $\frac{1}{4}$ of Sec. 16. The belt has the same quartzite as a footwall which underlies the hard ore in Sec. 15. Its width is not ascertained. 22 feet is certain but it is not further cross cut. Lengthwise the belt is followed for 700 feet. Next to the footwall on the south side are light-colored sandy argillites and adjoining these dioritic rock is said to occur. Further south, granite. Stayed at camp of Capt. Piece.

Friday July 28. Went by trail leading to mouth of Black River (22 miles distant) to a high melaphyr bluff in S.E. $\frac{1}{4}$ of N.E. $\frac{1}{4}$ of Sec. 9, T. 47, R. 46. Had a splendid view in all directions, particularly plain of the Iron Range 1 mile south of the bluff.

Left camp after dinner, found Mr. Piece and Mr. Day on the road. They went with us over the testpits in the windfall of Sec. 15 which show the formation to be mainly a quartzite formation with interlaminated belts of flaggy argillitic rocks of various impregnation with red oxyd. These flagstone layers are principally on the north side of the productive ore belts consequently above them. The footwall of the ore is a hard thick bedded granular quartzite about 30 feet wide. South of it are more or less light colored argillitic flagstones forming quite a succession (large) of beds. North of them, no exposures, but about 30 rods south the granite is said to be found.

From here followed the trail to Sec. 17 where Fay opened exploring pits, some of which disclose an ore belt from 15 to 30 feet wide very similar to the ore in Sec. 15. In Sec. 18 are likewise testpits opened exhibiting the ore bearing quartzite with good seams of ore inclosed. Went into camp near S.W. corner of Sec. 18 in a camp just evacuated by Pieces' men.

Piece went from here with us to testpits in N.E. $\frac{1}{4}$ of Sec. 24, T. 47, R. 47. A large number of them is opened and a dark blackish ore containing a large proportion of pyrolusite takes here the place of the hard ore with metallic lustre. In the pits of Sec. 15 also some softer reddish purple colored hematite is associated with it. The ore forms several belts, about 3 feet of clean ore, besides more or less wide belts of more mixed ore adjoining. Otherwise the formation is the same as in the other mines in Sec. 15, 16 and 17.

A ferruginous quartzite formation with interlaminated flaggy and argillitic layers, particularly the belt of flaggy argillites south of the footwall quartzite appears to be very wide. However from time to time quartzite beds are interlaminated. South of them dioritic rock is said to be found in a testpit, but the pit was caved in and I did not ascertain this fact. The granite is said to be 25 rods south. North of the ore bearing series of the quartzites very few exploring pits have so far been opened.

Saturday 29. Left camp in Sec. 18. Took trail to Montreal River leading over very nice hardwood lands. On the north slope of the iron range found some testpits near $\frac{1}{4}$ post on west line of Sec. 23 in which a black slaty rock is found near the surface. It is regularly found on the northside of the orebearing quartzite series.

From here to Woods camp on the banks of Montreal River on the fractional part of Sec. 21. $\frac{1}{4}$ of a mile north of the section corner which stands close by the river bed. 200 steps north of Sec. corner a wide belt of quartzoso ferruginous and calcareous somewhat brecciated rock ledges cross the river, dip northern, strike W.S.W. Further up the river in Sec. 27 the river bed is filled with large angular blocks of diabase (see specimen) but no regular outcrop discovered. Mr. Woods testpits are in the S.E. $\frac{1}{4}$ of the S.E. $\frac{1}{4}$ of Sec. 22, a mile from his camp. I went there in the afternoon but no testpit had yet reached through the surface material (clay and boulders).

I saw then about 300 steps south an outcrop of granite and advised him to stop all work in the various pits except the deepest one where I suggested he would soon strike the granite, and really a half hour afterwards they struck the solid granite which of course made them stop all the work in this part. I pointed him out a spot about 500 feet north to try another testpit to inform himself of the underlying rock.

Sunday July 30. Went by trail over to Wisconsin. Crossed Gogogashung River, the west branch of Montreal river close to the northern end of an island in the S.W $\frac{1}{4}$ of Sec. 27, T. 46, R. 2 East. The bed of the river is formed there by an ore bearing quartzite in a belt approximately 80 or 100 feet wide. South of it the whole island is formed by a belt of silicious slate rock about 400 feet wide and south of this is a dioritic schist, well laminated.

South of that commences the granite. We went on from there in a southwest direction along the trail. Passed the testpits of Prof. Ludlow. Now the place is further examined by Mr. Moore. The testpits in the centre of the north half of Sec. 33 conclusively exhibit the quartzites, in the Montreal west branch and the slates south of it besides the granite some little distance further south. All the productive ore bearing strata are north of these mentioned quartzites which correspond with the footwall of Pieces' exploring pits..

These ore bearing beds are partly quartzite beds with bunches of iron ore of partly very fine quality, partly the strata are of a more flaggy and partly argillitic composition all richly impregnated with red oxyd of iron but with intermingled seams 2 or 3 feet wide of a fine soft red hematite, or in places also a very homogeneous aphanitic pure hard oxyd occurs forming seams between the quartz rock. The dip of the strata is north under an angle of about 50 degrees. The width of the ore bearing belt north of the quartzite footwall I estimate at about 3 or 400 feet, not less. North of the trail no explorations have so far been made.

After dinner started west on trail. Met with some outcrops of dark banded lean ore in Sec. 32. Further on near Ryans camp in Sec. 1, T. 45, R. 1 East, the same lean ores form part of the hillside. Some of the ferruginous rocks form large slate like flagstones ringing under the hammer. Struck Potato River about in Sec. 19 and camped in an old Railroad Survey shanty close to the river.

Monday July 31. Followed the trail to Taylors fork, a branch of Bad River without seeing much of outcrops. On the other side of it however we ascended the high hills of Penokee Range and had frequent outcrops of steeply erected strata of the dark banded lean ores in massive ledges. Then again we crossed over belts of light colored hard slates or flagstones. Several times we passed along steeply erected bluffs of quartzite and limestone, both of which appear to be on the south side of the lean ores.

It rained all day severely and on the 20 miles long distance from Potato River to Penokee Gap we had all to do to get ahead and paid little attention to the frequent large outcrops of the iron formation which I expected to see to full satisfaction exposed at the Penokee Gap. Finally we arrived there at 5 o'clock in the evening all wet, even the interior of our packs which were more than twice as ponderous as when dry. Went with railroad at half past six from Penokee Station and arrived at Ashland stiff and chilly although the conductor kindly made for us a fire in the stove.

Went to Michigan Hotel, a modest inn but tolerably well kept. In the large hotel opposite the charge regularly \$4.00 per day which I considered too extravagant. Paid \$2.20 railroad fare for me and my packer. Paid him on account the sum of \$5.00 found in the evening Mr. Piece, Mr. Day and Mr. Moore. Met also again with Mr. Roy of Milwaukee. Could not sleep at night for pain in my leg from over-exertion in climbing dozens of these steep hills and descending again.

Tuesday Aug. 1. Rainy. Stiff leg. Packed my specimens and dried blankets, clothes and boots which were all wringing wet. Wrote home.

Wednesday Aug. 2. Went with train to T. 45, R. 2 W, Sec. 32, S.W. of S.W. Close to Bad River, where from formerly Ostrander had sent me specimens supposed to contain gold in payable quantities. Ere reaching this place near Silver creek large outcrops of granite are noticeable in the river. The gold bearing rock of this locality is a diabase belt of great width of a very different aspect in different places. Once a fine grained mass, other times formed of very large crystals of plagioclase and diorite. It contains in certain seams an abundance of iron and copper pyrites besides nickel and cobalt, silver and gold. This diorite is in connection with a fine grained granite in a large bulky belt but some large boulders lying near by are composed of the coarse diabase rock which is penetrated by a narrow dyke of granite. Also large granite boulders are there which inclose completely fragments of this diabase. Further along this chain of outcrops is a contorted and brecciated gneiss rock which forms part of the dioritic hill chain.

Toward Penokee the outcrops disappear for awhile until in sight of the depot a cut of the railroad exposes black silicious and pyritous slaty rocks in a large succession. The slaty structure of the rock is not everywhere plain and some of it is hard semi-crystalline.

South of it is an interruption the follow similar black slates until to the water house at the station. Then follows the so-called magnetic belt which consists of a large series of banded actinolitic quartz schists just like the actinolite above the ore belt of the Michigamme mines. The lower strata are dark purplish blotched and less thinly laminated. They are not actinolitic but consist of alternating lenticular laminae of quartz and magnetite.

Under it is the large series of silicious slates of a dark grey color. Then follows a 40 feet wide belt of white compact but veiny quartz which insensibly graduates into a limestone belt about 90 feet wide. All these beds dip north. On the south side of the limestone follows a dark granite dipping south with its well laminated layers some of which are a well banded hornblende gneiss.

Diagram

Thence a large space without outcrops. Further north a cut through the so-called black feldspathic schists which scarcely differ from the former. Goethensberger found graphite seams in these black slates.

(Pencil notes. Sulphuret of silver 25 miles north of Silver Island. Porphyry hanging, slate footwall. Within $1\frac{1}{2}$ mile from Lake shore in Black Bay. From Canada. H.E. McDougal, Ashland. Graphite 3 miles east from Penokee in Sec. 8, T.44, R.2 W. together with black slate of iron formation.)

Thursday Aug. 3. Stayed at Ashland on account of stiff leg. Saw some fine specimens of silver and sulphuret of silver at Mr. Becks, an old miner in the north shore district. Got some specimens from him, 25 miles north of Silver Island, porphyry in the hanging slate rock footwall. Got another fine specimen of argentiferous lead ore from Black Bay $1\frac{1}{2}$ miles from lake shore from Mr. H. E. McDougal. Promised him an analysis. Saw at Mr. Vaughans' (pronounced Vaun) office graphite which forms a belt 14 feet wide in the black slate of the iron formation in Sec. 18, T. 44, R. 2 W. 3 miles northeast of Penokee Gap.

Saw also a drawing of a furnace constructed by a Mr. Hamilton, N.Y. to work over the tailings of South American gold mines by running them through a machine with molten lead at a heat of about 1100 degrees. The oxidation of the lead is prevented by the burning of charcoal in the channel admitting the air. The tailings are first roasted in a furnace and transferred hot by a revolving hoisting machine into the furnace proper. Provisions \$7.00 Hotel bill \$14.00

Diagram

Friday Aug. 4. Went by sailboat at 8 o'clock to Mouth of Montreal River. Arrived there Saturday morning at 4 o'clock. Very cold night. No sleep.

Saturday Aug. 5. Sent Hunt with Mr. Gillis back to Rockland. Went on Wisconsin side along lake shore which is lined with high clay bluffs. Near the waterline a large series of dark brown sandstones occasionally mottled with white streaks and blotches crops out at the base of them. They dip under an angle of 50 degrees to the north. Among the pebbles on the shore a large proportion of porphyry and amygdaloid rock besides granite, diabase and diorite, also Devonian limestone pebbles abounding in fossils are very numerous there. Collected gneiss boulder with garnets and a variety of porphyritic and amygdaloid pebbles.

After dinner with boat to falls of Montreal. About 400 steps from the entrance both sides high bluffs of dark brown, partly argillitic sandrock with almost vertically erected ledges inaccessible on either side. Falls in offsets about 80 feet above a long series of rapids, and another fall in terraces from 3 to 6 feet.

I followed the river for nearly a mile from its mouth and found it crossing the sandstone formation exhibiting a thickness of not less than 3000 feet. All strata dark brown or reddish, some hard, more or less micaceous, others more soft and some earthy, easily disintegrating into a sandy clay as for instance those at the entrance.

Sunday Aug. 6. Remained in camp as my foot was still sore when I walked. Weather fine, lake quiet, perfectly smooth.

Monday Aug. 7. To old mining location on Montreal River. 5 miles above its mouth followed an old wagon road now used as a trail of the iron miners. At the location which is at the foot of high bluffs in the bed of the river a trap belt of about 80 or 100 feet in width strikes across the river. North of it are some argillitic sandrock layers and between them an amygdaloid trap belt about 10 or 12 feet wide is enclosed which is connected with a sparry seam containing prehnite and some fine scales of copper.

Further north is a very large belt of conglomerate with interstratified seams of fine grained argillitic sandrock, exhibiting plain ripple marks. Strata dip under an angle of 70 to 80 degrees north and seem to be succeeded by other similar sandrock strata down to mouth of river. On the south side of the trap are likewise similar argillitic sandrock strata amounting to a great thickness but I followed the stream no further upwards.

Returned to camp as my leg became swelled and painful from the exercise I made. No outcrops seen on the way to camp except in the creek entering the lake at our camp. It is the red sandrock as seen along the beach.

Tuesday Aug. 8. Stormy weather.

Wednesday Aug 9. Paragraph in German.

Thursday Aug. 9. Evening Moore comes with the boat. Sail for mouth of Bad River arrive at 9 o'clock in the evening.

Friday Aug. 10. Waited all day for favorable wind. Indian left the boat to go to land. Did not come back. In the afternoon heavy storm. Tug Wadsworth went up the river. Returned 6 o'clock in the evening. Took me aboard but had to stay in the river over night. Morning went 4 miles up the river again to get breakfast on board of another boat belonging to one of the saw mills at Ashland. ~~Left for Bayfield about 9 o'clock Saturday morning Aug. 11.~~ Returned to mouth of river and remained there until Sunday morning at 6 o'clock when the sea had calmed down.

Sunday Aug. 12. At 12 o'clock arrived in Ashland.

Monday Aug. 13. Packed two boxes of specimens. Shipped them by railroad. The Steamer Manistee left yesterday morning for Houghton. I have to wait for his return and down trip unto Thursday morning. Paid for transportation of baggage from boat 50 cts. Fare from Bad River to Ashland \$2.00. Board at Michigan Hotel from Sunday noon to Monday noon. Did not wait for Manistee and took a boat to Bayfield taking my chances for a boat going to Houghton. Tuesday the Peerless came and loaded lumber 250,000 feet which took him unto Wednesday morning Aug. 15 when we started. Fare to Houghton \$7.00. Hotel at Bayfield \$3.00. The shore at Bayfield is formed of drift bluffs beneath which in many places the horizontal Silurian sandstones make their appearance.

Wednesday Aug. 15. 11 o'clock at night arrived in Houghton.

Thursday Aug. 16. Got letters from home and Vienna, but not the expected draft from Savings Bank. Saw in the office of a retired banker, John Jesson, a slab of slate from environs of LeAnse with a compressed body about 8 inches long and about the delineated shape.

Diagram.

Its surface is very delicately wrinkled and it has much the appearance of an organic remain but I am doubtful about it as also the surrounding slate mass shows delicately wrinkled structure evidently due to the pressure of a soft mud mass.

He gave me a piece of a very large concretion of Datolith with inclosed crystals of copper from the Franklin mine.

Sent letter to Mr. Cheneaux, hotel keeper at Rockland together with \$41.00 money order to pay my packer Mr. Hunt and other expenses for transportation of specimens from Lake Cogebic.

Notes from back of book. T.W. Edwards, Houghton. R. Owen

1. melaphyr belt from road up the hill to laumonitic amygdaloid 90 steps
2. Laumonitic amygdaloid with datolith nodules in crumbly decomposing masses with massive concretions of epidote 16 steps.
3. Melaphyr with epidotic blotches, over 200 steps to, past candle factory where amygdaloid and epidote seams are connected with the melaphyr.
Epidotic amygdaloid 18 steps. Amygdaloid intermingled with brown sandrock masses in brecciated intermixture 10 feet.
Brecciated epidote and amygdaloid 10 feet all in decomposing crumbly condition
Melaphyr unto town, large belt

Sunday Aug. 20. Packed 3 boxes of specimens. Forwarded by Mr. Hoar. Paid for man Hunt 21 days, \$42.00. 2.50 for transportation of specimens. 1.50 Hunts board bill, 25 cts for wrapping paper.

Peter Gotstein, Candle manufacturer, Houghton

Aus luyen fur(outlay for) Geol. Survey May 1883, Felt material 24 yards \$5.00
\$3.00

Two page diagrams

Brown Escanaba, S.W. $\frac{1}{4}$ Sec. 34, T. 46, R. 33. Outcrops of good lean ore. North of it diorite, dip S.W. Close to old trail from Republic to 3 lakes on town line.

Diagram Quinnesec

Menominee Sec. 9. Shaft 56 ft. deep. First mixed ore and 4 feet of good ore. Dip S.E. Under it a sandy argillite with glossy quartz concretions and of red and white mottled color forms bottom of shaft.

Diagram

Mouth of Paint River. Strike E and W. Dip S. Large belt of hard quartzose feldspathic rock. 300 steps further down the river softer mica schists. No. 2. About 200 feet or more, then a belt of hard rock like No. 1. Marked 3. 4 a hard absorbent partly micaceous rock. 5 more micaceous, slaty and softer, both 150 steps in extent.

Diagrams

Fischer Camp. Strike N N.W. Dip vertical, a little to the north. Argillitic schists more or less impregnated with iron and some narrow bands of quartz. A row of test pits run across the formations. North pit 500 feet from east line. Distance to pits with pyritic graphite schists about 850 feet. Between this and the argillites a broad belt of green schists resembling dioritic. Next north of which a belt of hard iron stained whitish quartzrock lays on the graphite schists.

And apparently below the green schists are hematitic quartz strata holding much of concretionary masses of iron ore, but the strata are at the surface all broken up into small pieces.

Chas. Hopkins, Ashland. V W. Newland, Ashland.

Michigamme mine. West pit. Ore 15 to 20 feet. North white quartz banded magnetic ores(mixed) resting on the garnetiferous chlorite under which another ore belt follows. North of ore belt 40 to 50 feet of thick bedded grey quartzite. 100 feet of actinolite schists, the lower more chloritic and garnetiferous, the upper more arenaceous containing seams and breccia like lenticular lumps of a grey granular quartz rock. Northern layers become almost horizontal. Then short interruption and further north banded garnetiferous schistose actinolites with quartz and chlorite seams partly brecciated.

E.H. Wright, Republic G. E. Hall.

Magnetic mine drill hole 585 feet deep and 632 from surface. Lowest a whitish quartzite rock 100 steps. Quartzose graphite schists to openings of ore seam at falls. About 800 feet visible of dark quartz schists banded with slaty graphitic seams and impregnated with iron and iron pyrites. Natural silvery cleavage surface shining like varnished. Fresh fractures rough, gritty.

Phillip Kohl, Ashland.

Brunswailer Co. Vein $2\frac{1}{2}$ ft. wide, ore specimens and surrounding wall rock.

Bufford mine, N E $\frac{1}{4}$ of Sec. 22, T. 48, R. 31.

Northrop Sec. 26, N E $\frac{1}{4}$.

Crystal Falls cut. 210 steps slate, Dip S.W., strike N.W. to S.E. 100 steps ? 80 steps similar slates but with a quartzose seam and more dark ferruginous partly graphitic.

Keystone mine. Quartzite visible 30 ft. Mixed ore 25 ft. Garnetiferous chlorite mixed with ore 25 ft. banded silicious ore, very thick belt. Dip north.

In second pit at the carpenter shop. Quartzite, micaceous quartzose argillites of white and reddish color 3 ft., ore garnetiferous chlorite as before slaty beds at footwall.

For washing June 27, Marquette. 2 wool shirts, 2 wool socks, 1 pair of underwear 1 sacktuch (robe)

Diagram

Hunt 20 days \$40.00 \$5.00 advanced (or previously paid).

Sec. 34, T. 45, R. 30 Koch

C. Rominger 1883

May 17. Left Ann Arbor by Toledo Ann Arbor Railroad. Arrived at Marquette Friday 12, 6 in the evening. The bay is full of ice(eis) yet. Stopped at Tremont House.

Saturday 19. Went with railroad to Ishpeming to examine Roads Gold mine in Sec. 29, T. 48, R. 27. Railroad fare to Ishpeming and return 1.30. The first explorations of Mr. Ropes were made short distance east and somewhat south of the limestone outcrops described in my report as occurring on the northside of the road. A narrow quartz vein only 3 inches thick slightly impregnated with sulphurett of iron, copper lead and carrying some silver and gold is found there intercalated between schists of green color (talcose?).

North of the schists succeeds a limestone belt about 30 feet thick of grey mottled banded and seamy crystalline structure resembling more an intrusive mass than a stratified series of beds. The limestone incloses an abundance of lenticular masses of a fine green colored talc. It is at present used for a flux at the Deer Lake furnace. North of the limestone a massive serpentine adjoins it closely. The limestone belt strikes nearly east and west and crosses the road further west where on the south side of the road about half way up the hill sides other exploring pits are opened about in the horizon of the limestone belt and in the schists next south of it.

Several veins of white quartz some 5 or 6 feet in width are found there striking with the formation which locally are richly charged with the sulphuretes of lead, copper, zinc and iron, besides gold and silver in small leaves and in minute nuggets. A ton of such quartz contains from 10 to 100 dollars worth of gold which is frequently visible with the naked eye. South of this quartz which is not a fissure vein but rather a segregated band in the formation is serpentine rock and then again another limestone belt follows. The quartz veins are intimately connected with the limestone belts. Sent a box with specimens from that locality to Ann Arbor. Bought from Mead a deerskin at 2 dollars.

Sunday May 20. Snowstorm nearly all day. Wrote home.

Monday May 21. To Houghton by railroad. Bought 50 cigars for 3 dollars. Hotel bill 6 dollars. R.R. to Houghton 4.30. Ordered maps of Keweenaw point. Arrived at Houghton half past 8. Supper at boat 50 cts. Cartage for trunk 50 cts to R.R. from boat.

Tuesday 22. Very cold but clear sunny morning. Went over the grounds of the Portage lake mine. The ore bearing epidotic melaphyr strikes N.N.E. to S S W. forms part of a very wide belt of melaphyr which occupies the entire width of the property. The vein is near the eastern limits of the $\frac{1}{4}$ section and crosses over to the Sheldon and Columbia property northward. Its southern continuation is mined by the Huron mine. In several consecutive shafts on the west side of the Portage vein a small quartzose calcareous transverse fissure vein is noticeable at the surface which carries some blue sulphuret of copper but it is not considered as worth further exploration. Afternoon went east across the Sheldon and Columbia property to the Isle Royale property to see the old trenches of Mabs but found them all obliterated.

Wednesday, May 23. Went to Isle Royal property where I was yesterday. Passed the old shaft which is situated near the N.W. corner of Sec. 6, T. 54, R. 33, probably the Mabs(Maps) vein. From there went south along road until I struck the line of test pits and trenches formerly opened on the Isle Royale property by Maps. A conglomerate belt crosses the road there. Followed the trenches in which generally melaphyr and amygdaloid has become exposed.

After some progress another conglomerate belt is met with, then again amygdaloidal melaphyr approaching the creek which flows diagonally across the S.E. $\frac{1}{4}$ of the N.W. $\frac{1}{4}$ of Sec. 6. A third large belt of conglomerate is met with. Its strike is N.E., its dip N.W. under an angle of about 50 degrees. Some of the beds are fine grained sandrock. Others are filled with large porphyritic brownish red pebbles. Under this conglomerate is a brittle amygdaloid belt exposed with Delessite and calcspar nodules abundantly disseminated. Also soft Kaolinitic amygdules are common in its quartz.

Close to these exposures still not seen in immediate contact on account of the talus are horizontal silurian sandstones red and white striped and mottled. They can be from here seen all the way down in the bed of the creek.

Returning I followed the trenches trying to keep account of the successive strata but they are nearly all refilled with rubbish and I had to give up the attempt. I presume the description given of them by Pumpelly as he copied it from the records of Mr. Maps, are correct.

Thursday May 24. Went from Houghton to Atlantic Staap mills examining the exposures along the road side. Identified some of the strata indicated on Pumpelly's map but failed to see all the different conglomerate beds, as for instance the one on Montezuma property, numbered 12. Then on south side property 20, 21 and 22.

From Hancock conglomerate 17 and from 18 particularly from the latter took specimens of inclosed pebbles. Also specimens from coarse melaphyr on Dakotah property and a quartzose amygdaloid melaphyr next east of there. Also specimens of coarse grained melaphyr a few hundred steps east of candle factory.

Examined after dinner the conglomerate belt exposed on the west side of the school house. The belt is about 20 feet thick partly epidotic. Pebbles about the same as in the more western conglomerates, less crystalline on fractures, more a finely granular mass with dimly defined segregation of feldspar crystals. They are also less porous in the cement, probably by alteration from the surrounding melaphyr by heat. Rain set in, driving me home.

Friday May 25. Went to Hancock mine and thence west along hill side where lately trenches have been dug in which about 200 steps west of the mine a belt of coarse conglomerate about 30 feet wide is uncovered. Next west is a belt of melaphyr which on the west side changes into an amygdaloid. At about 300 steps from the mine, another conglomerate belt and sandstone ledges without pebbles succeed in a thickness of about 40 feet. Further on the surface is covered with drift but about 200 feet further a third belt of conglomerate 240 steps wide becomes exposed due north of the graveyard along the bed of the railroad part very coarse pebbly, part more sandstone-like.

Next west of it succeeds a large belt of brown amygdaloid with rather large and abundant amygdules of quartz calcspar Delessite. West of it is compact melaphyr which from time to time becomes again amygdaloid. The porphyritic pebbles in all the 3 belts do not seem to differ. Some are almost aphanitic vitreous in fracture, others perfectly crystalline granitoid. Some melaphyr pebbles are likewise occasionally found inclosed.

Afternoon went to Pewabic mine and examined the conglomerate belt, about 3 or 400 feet east of the Pewabic Rockhouse.

The rock is partly a fine grained brownish red sandstone, partly a coarse conglomerate very compact, breaking smoothly across the pebbles, which seem to be the same as those composing the conglomerates west of the Hancock mine. Hunted for exposures of the conglomerate on west side of Pewabic but could not find the trenches said to exist.

Sandstone strata west of Atlantic Stamps strike from N W. to S. E. Dip S.W. under an angle of 35 degrees

Diagram

Further up the hill the strike is almost N. and S. Dip west. Creek outcrop above section. N.E. strike. N W dip about 30 to 35 degrees. Paid man to help carry specimens 1 dollar.

Saturday May 26. To creek on west side of Atlantic Stamps following the road up the hillside a large series of dark reddish brown sandstones with much lammonite as cement alternating with conglomerate beds crosses the ravine. Striking about N. west and dipping S.W. under an angle of about 35 degrees. Further west along the lake shore are no exposures. The steep hills along which the aqueduct runs, consist altogether of drift sand with boulders.

At mid-day to Swede Creek by a good road leading there around the base of the hills in the S.W. quarter of Sec. 28, T. 55, R. 34, large succession of exposures of first lammonitic conglomeritic sandrock, then of grey colored more fine grained micaceous flaggy or slaty sandrock with ripple marks. Strike of strata N.N E. Dip N W. under an angle of about 30 degrees. The succession amounts to over 1000 feet. A continuation of exposures of similar flaggy or slaty nature is found in Swede creek which runs diagonally across the south half of Sec 22. These beds added to the succession of the former make the series near 2000 feet thick. Strike and dip the same as above stated.

Sunday May 27. Went to Ryans mine on 6 mile hill, left side of the road where a very rich belt of amygdaloid lately has been discovered. The amygdaloid contains almost exclusively calcspar quartz and Datolith. In its amygdules the copper occurs in larger masses from a pound upwards. Fine copper granules are very sparingly found. Small fissure veins in the rock are filled with calcspar, Datolith quartz and arsenate of copper besides metallic copper.

Paid for Horse and carriage 3 dollar. For 4 pounds of wrapping paper .40

I am told that large bulky masses of arseniate of copper were formerly found in an abandoned mine about $\frac{1}{2}$ a mile this side of Ryans mine on the right side of the road at Brown and Devreaux mine.

Monday May 28. Went to Atlantic mine. Amygdaloid bed of chocolate brown color rather poor in copper but in patches rich. The average yield about $\frac{3}{4}$ of one per cent. Dip of bed about 55 degrees. 31 feet west of the amygdaloid a conglomerate bed 50 feet wide. Then another amygdaloid, both barren of copper. A calcspar vein intersects the ore bearing bed obliquely. It is not metalliferous. Still occasionally contains copper and silver. The copper bearing amygdaloid where it is intersected by the fissure vein is barren of copper.

The Quincy vein is supposed to run through about 1400 feet east of the mine. The mine is at present 1400 feet deep. Captain of Atlantic mine Duncan. According to the statement of the captain of the Huron mine the Ryan mine vein is about 1000 feet west of the Huron vein. The miners vein nearby containing arseniate of copper is likewise about 800 feet west of Huron vein. The same vein is traced on the Huron property between the shaft No. 6 and the Huron stamp mill.

Tuesday May 29. With stage to Torch Lake 2 dollars. Dinner .50 Followed the Hungarian creek upwards. The first falls about 100 feet high are caused by an escarpment of horizontal sandstone strata of which lower beds are exposed all the way up in the sole of the creek below the falls. The sides of the ravine are unaccessibly steep and the valley is so narrow that I had to wade in the water.

Above the first falls are several others from 20 to 30 feet high all formed by horizontal ledges of sandstone. Finally near the top part of the ridges another fall about 25 feet high is formed by upheaved conglomerate beds which rest towards the base on a belt of amygdaloid about 30 feet wide which on this(his) part is in direct contact with horizontal silurian sandstones. The contact is visible in the bed of the creek, but not on the sloping sides of the ravine which are covered with rubbish. The assertion of Wadsworth that the sandstone dips under the amygdaloid is totally incorrect. The sandstone dips away from the hill than towards it. It differs lithologically from the sandstones of the copper formation by its purely quartzose composition stained with iron pigment.

The sandstones of the copper formation are more ferruginous, contain feldspar and are much harder, fine grained, or if coarse composed of dark grains of comminuted melaphyr or porphyry prevailing over the quartz grains. The whole of the lower hills surrounding Lake Linden consists of horizontal silurian sandstones and of drift masses. Visited the Calumet and Hecla Stamp mills.

Wednesday 30. To Wolverine mine, Calumet and Hecla and Osceola mine. The Wolverine is now well opened and has a stamp mill in operation. In the prolongation of the amygdaloid belt into the Kearsarge property likewise test shafts have lately been opened which prove the vein to be equally rich there. The copper in the amygdaloid near surface is much oxydized into malachite or into red and yellow oxyd. The foot-wall of the copper bearing amygdaloid is a coarse grained melaphyr belt about 70 to 100 feet wide projecting in cliffs at the eastern base of which a belt of sandstone is seen to underlie them. The foundation of the stamp mill rests on this sandstone.

Further east comes again melaphyr. The Wolverine belt is supposed to be 2300 feet east of the Calumet and Hecla conglomerate. Between both is another belt of copper bearing conglomerate. The Kearsarge conglomerate worked on the Kearsarge property or former Seneca mine. From Wolverine walked along the Calumet conglomerate belt to Osceola mine. This belt is there finely denuded in an open pit for over a hundred feet in length. In the superficial rock most of the copper is altered into green and red oxyd. The conglomerate belt of the Osceola is not worked now. All the work done there is in the amygdaloid belt underlying the conglomerate. Expenses R R. 1.50 stage .50, dinner .50.

Thursday May 31. To Albany and Boston mine 40 cts. Return 40 cts. At the Albany and Boston mine a new stamp mill has been erected. The conglomerate is as a whole rather poor in copper but in some portions coarse seams of the metal almost replace the cement mass.

In the surface portions of the rock part of the copper has been transferred into red oxyd and malachite. About 100 feet west of the conglomerate belt is a row of old shafts from which an amygdaloid is hoisted which carries considerable copper associated with prehnite, analcim quartz, Orthoclase in compact seams or also in drusy cavernous masses, the cavities of which are lined with fine crystals of these minerals.

The conglomerate belt can be traced on the east side of the road to the Franklin as on this interval frequent old mining shafts are met with which exhibit the conglomerate rock on their burrows, but it seems to be barren of copper in most of the places. Close on the west side of these shafts are others in which an epidotic amygdaloid is found which is probably identical with the Boston and Albany amygdaloid.

At the Albany and Boston mine near the old stamp mill 475 feet west of the conglomerate belt is another amygdaloid belt opened which carries copper and within this belt a seam of a reddish colored, peculiarly laminated banded rock occurs two feet in width which also carries some copper. It resembles a sandstone in superficial aspect but closely examined it consists of a brown flinty ground mass like the porphyritic conglomerate pebbles in which whitish semi-kaolinitic weathered feldspar crystals are copiously disseminated.

Friday June 1. Visited Hancock mine. The brown amygdaloid full of Belessite nodules and other portions with calcspar and lammonite forms as it appears from the open pits around the mine a very wide belt. Copper is generally scarce but locally rich deposits occur in granular distribution or also in masses from several pounds to several hundred pounds. Obtained in the rockhouse a very rich specimen. The copper is there distributed in a sparry fissure seam of the amygdaloid.

Met returning from the mine Capt. Ryan of the Hancock. Was invited to see the mine again under his guidance. Afternoon went to the abandoned Douglas mine which is considered a continuation of the Isle Royal belt, likewise the Concord and Arcadian mines, two other abandoned mines adjoining. At the Douglas I found the vein matter to be a hard epidotic amygdaloid rather barren of copper as far as I could judge from the examination of the burrows. Red compact feldspar seams and calcspar are the prevailing accessory minerals in the rock. The foot and hanging of the epidotic vein is a dark melaphyr of middling coarse crystalline grain. On exposure it becomes light reddish grey mottled with dark delessite (green) spots.

Saturday June 2. Went to exploring trenches on Isle Royal property east of the Huron mine. The conglomerate No.7 is well exposed there. Conglomerate No.6, I could not observe as the trenches are filled with rubbish. The intermediate rock is melaphyr of dark color, most of it fine grained. Alternating with it are epidotic amygdaloids apparently barren of copper.

In one of the melaphyr belts near conglomerate No. 7 are streaky banded seams of a red porphyry-like rock mass in irregular seemingly intrusive bands penetrating and intersecting the melaphyr. Afternoon rain.

Sunday June 3. Went over Sheldon and Columbia mine. Found some silver in calcspar. The Sheldon and Columbia and the lower shaft of the Portage mine is on the Portage belt. The Isle Royal belt is 200 feet east of the Portage belt. The upper shaft of the Portage is on the Isle Royal belt. Visited Mr. Hudson in the afternoon.

Monday June 4. To Calumet and return. Railroad fare 1.30. Went to see Mr. Daniels Capt. of Osceola mine and of the work at Tamarack shaft. This shaft is at present 740 feet deep. The strata dip at an angle of about 37 degrees like those at the Hecla. First about 50 feet of drift had to be sunk through before rock was struck. The upper 460 feet consist of alternating beds of melaphyr and amygdaloid which latter carries considerable copper. At 463 feet a belt of reddish jaspery rock 2 to 3 feet thick is sunk through which likewise carries copper. Then follow again amygdaloid and melaphyr. The lower melaphyr is dark blackish, segregating in irregular small fragments with shining chloritic slickenface coating and on those faces covered with sheets of leaf copper very abundantly. This blackish melaphyr forms the hanging of a conglomerate 3 or 4 feet thick, cupriferous. It is struck at the depth of 673 feet and supposed to be the equivalent of the Allouez conglomerate.

According to direct measurement on the Seneca property the Allouez conglomerate is 1570 feet apart from the Calumet conglomerate or in horiz(ontal) distance 2260 feet from the supposed Calumet conglomerate to the Osceola amygdaloid, 528 feet or horizontal 760 feet from Osceola amygdaloid to Kearsarge conglomerate 549 feet or 790 horizontal.

The Calumet conglomerate is at the mine from 12 to 25 feet thick but thins out in places to a seam only few inches thick as for instance at the schoolcraft mine where the widest measure of 25 feet and the smallest of only few inches is represented. The dip of the conglomerate at the Hecla mine is under an angle of 37 degrees. Distance from Calumet conglomerate to Kearsarge vertical 1077. (According to Pumphelly maps 1064 and distance from Calumet to Allouez 1432, in another place 1394 feet). (From the German) I copy from Pumphelly, distance from Allouez or Albany and Boston conglomerate to No. 16 or Pewabic west conglomerate 1146 feet and from 16 to 17 or Hancock west 505 feet.

Dienstag (Tuesday) June 5. Till mid day dark, rain. At mid day to old shafts of the Isle Royal mine. collected fine specimens of analcim ectr.

Wednesday June 6. To Torch Lake with stage. 2 dollars for return trip. .50 cts dinner. Went to Douglas Houghton falls in Sec. 31, T. 56, R. 32. The falls 75 feet high over trap. Above falls for some distance all trap. Below the falls some mining explorations have been made. Small fissure veins composed of calcspar, prehnite, datolith quartz carry minute granules of copper. The trap is partly amygdaloid. Dips under an angle of about 35 degrees N.W. descending the ravine. The trap beds are alternating with soft shaly seams of trappose nature readily disintegrating into a crumbly mass.

Next to the lowest trap bed which is partly amygdaloid and partly of the above mentioned shaly nature follow beds of conglomerate and sandstone striking and dipping as the trap does. The alternation of conglomeratic beds with sandstone layers which sometimes resemble the Silurian Lake Superior sandstone by being comparatively soft and porous and often rather light colored is very considerable in thickness and forms the sides of the ravine for quite a distance downward returning (retaining) about the same dip. Finally the outcrops become very obscure and the embankments are a soft mass of sand and pebbles intensely red colored and not exhibiting distinct stratification. Still descending under this gravel and sand mass the horizontal silurian sandstone strata come to the surface and are exposed all the way down to the bottom of the valley.

The upper conglomerate and sandstone beds are in part compact and hard but most of them are soft easily disintegrating and would if they were horizontal unhesitatingly be considered as silurian. Still the pebbles of porphyry and trap they inclose are the same as in other conglomerates of the copper bearing series and as they dip likewise under an angle of about 35 degrees to the northwest I have no doubt they belong to the copper bearing series. The horizontal silurian sandstones are not seen in contact with them. Also is the statement of Wadsworth totally false that going down the creek a gradual diminution of the dip of the strata is observable until the lower beds have become horizontal. There is only an abrupt change, the upper ones are strongly inclined and then no exposures for a good distance until we find the beds horizontal.

In going up the inclined of the Calumet railroad I observed in the quarries there the well denuded horizontal silurian sandstones. Following from here the railroad track for a $\frac{1}{2}$ mile further other exposures of the same sandrock are seen. Then after a short interruption of the exposures we find on the roadside next to two farm houses and before the footpath to the falls branches off, a broad belt of quartz porphyry dipping northwest with considerable inclination, contains copiously interspersed hexagonal quartz grains with glassy fracture appearing black on reflected light but actually colorless and transparent as the quartz of the Calumet conglomerate which that rock most resembles.

Thursday June 7. Office work. Paid 13 dollars for 13 maps. Wrote home.

Friday June 8. To Calumet and return 1.30. Dinner .50cts. Went first to dam of Calumet mine near N.W. corner of Sec. 13. Found the Allouez conglomerate belt exposed in a pit right under a black decomposing melaphyr in the hanging of the conglomerate of the Tamarack shaft. Visited then agent Wright of the Calumet mine and obtained from him the following records of the cross cut from Calumet conglomerate eastward. Commencing at the foot wall of the Calumet conglomerate.

1. Melaphyr to 178 distance. dip of strata 39 degrees.
2. From 178 to 209 amygdaloid, calcareous, vertical thickness 19 ft.
3. Melaphyr to 458
4. Amygdaloid to 475 calcareous. Thickness 10.5 ft.
5. Melaphyr to 529
6. Amygdaloid to 600, calcareous. Thickness 43.7
7. Melaphyr to 730
8. Amygdaloid to 809, calcareous. Thickness 48.6
9. Melaphyr to 947
10. Amygdaloid to 973
11. Melaphyr to 1005 inclosing a small spar vein
12. Melaphyr to 1156
13. Amygdaloid to 1169
14. Melaphyr to 1490
15. Amygdaloid to 1511
16. Kearsarge conglomerate to 1615, calcareous, Thickness 63 ft. Carries little copper in the hanging part.
17. Melaphyr to 1955. The present distance reached. The drift will be continued to the limits of the property.

In the afternoon re-visited the Tamarack shaft. Collected some additional specimens. Then walked to the Albany and Boston. Saw some test pits on the Tecumseh property west of station where the Calumet belt is said to have been found for the last time but the pits are now all filled with sand and drift masses.

The Albany and Boston belt is exposed in old mining locations near the half way house. The Houghton conglomerate said to be exposed in pits east of these mining pits I had not time to examine this time as I wanted to return with the train to Houghton.

Saturday June 9. Cloudy cold day. Remained at office in the morning writing out notes and packing specimens. Afternoon went to creek on Dakotah property to examine conglomerate belt NO.14 but found only melaphyr exposed. Creek difficult to follow.

Sunday June 10. Went to Swede Creek examining the sandrock series exposed on the road to the creek. Their strike is conformable with the melaphyr belts of the Quincy ectr. Examined the hills on west side of creek. Found no rock exposed. They consist from bottom to top of drift masses. The same is noticeable of the hills on the other side of Portage canal. S.C Hill whom I met last evening told me of an exposure of a large conglomerate bed west of the creek but did not indicate where or how far west. 20 days board due. Paid 16.00

Monday June 11. To Eagle River 2 dollars fare. Arrive after 1 o'clock noon. Examined the exposures of conglomerate on the beach south of Eagle River. This conglomerate belt is very wide and dip is about 25 to 30 degrees. At the bridge the river forms falls and the strata are finely exposed. An amygdaloid melaphyr forms the rock bed of the river at the top of the falls. At the base of them it is an uneven somewhat rugose surface, overlaid by an even bedded fine grained dark brown sandrock which exhibits no signs of alteration and seems to have been deposited on the indurated surface of the trap rock. A series of about 60 feet of such even-bedded sandstones succeed which occasionally are mixed with scattered pebbles.

Higher up in the succession of deposits the conglomeratic nature of the strata begins and for 500 or 600 feet in thickness only very few narrow bands of sandy nature were observable. The conglomerate is coarse with pebbles from the size of a hen's egg to a man's head. Most red porphyry partly with aphanitic matrix, partly throughout crystalline also amygdaloid melaphyr boulders are among the pebbles inclosed.

7 pages German.

Thursday June 14. Section into hill by tunnel commencing at the stamp mills of Copper Falls. Average dip of strata 27 degrees, measurement of strata horizontally. The broad conglomerate belt analogous to the one at Eagle River lies little distance further off toward the lake and beyond it in the lake are cliffs of the amygdaloid melaphyr seen at the lighthouse of Eagle Harbor.

The tunnel commences in an amygdaloid bed overlaid by a thin sandstone belt. The thickness of amygdaloid horizontally about 100 feet. Then a belt of sandstone 100 feet. Then conglomerate 25. Then sandstone 100 feet. Melaphyr 220 feet, sandstone 75, melaphyr 50, sandstone 90, melaphyr 400 sandstone 220. Here a shaft strikes the sandstone about 175 feet below surface.

(Line drawn thro this paragraph) Melaphyr 500 ft. Sandstone several thinner belts alternating with amygdaloid, measurement not clearly visible on map. About this horizon a thin feldspathic amygdaloid seam rich in copper. Thence 500 ft. of melaphyr then thin seam of amygdaloid about 2700 ft. from mouth of adit. Here begins the principal work of the mine.

Another map.

1. Conglomerate not determined thickness.
2. Silver bearing amygdaloids in various different belts amounting in total to 400 feet. Shaft sunk through them on lower part of hill.
3. Sandstone 200 feet.
4. Bluish grey amygdaloid 100 feet
5. Sandstone seam small.
6. Bluish grey amygdaloid 350 feet
7. Conglomerate 25 feet
8. Melaphyr 100 feet.
9. Sandstone and conglomerate 125
10. Melaphyr 100
11. Feldspathic amygdaloid, copper bearing, thin seam.
12. Melaphyr ~~about~~ 500
13. Amygdaloid 400 ft. various nature, one of them prehnite bearing
14. Melaphyr 150
15. Amygdaloid 25. Shaft Thomas.
16. Melaphyr 250. At base slide
17. Amygdaloid 90
18. ~~Melaphyr~~- 150 ash bed
19. Amygdaloid about 20
20. Melaphyr 200
21. Amygdaloid 20
22. Melaphyr 200
23. Amygdaloid 20
24. Melaphyr 100
25. Amygdaloid 100
26. About 300 feet of melaphyr with some amygdaloid seams. Lowest reached in the mine. The upper shaft, Thomas shaft is 390 feet deep. Commences in amygdaloid. No. 15

Spencer shaft commences upper portion of amygdaloids No. 13.

The above succession of beds is copied from the mining map of Copper Falls but with regard to the special characters of the different strata no clue could be found in the map nor could Mr. Emerson furnish reliable information. Several of the different amygdaloid belts observed in outcrops on the surface can be lithologically distinguished by one familiar with the locality but this task of distinguishing is for a stranger passing over them not possible at first sight.

Went to the stamps of Copper Falls at the foot of the hills where the adit to the mine is but did not examine the tunnel. Most of the intersected beds can in some place be seen in natural outcrops by roaming over the hill side.

Went to the adjoining abandoned mine, the Patrick mine where likewise tunnels have been driven from the slope of the hill to the so-called ash bed and quite a distance across and beyond it into other belts of melaphyr and amygdaloids. A large portion of these tunnels have caved in and are no more accessible

On the Copper Falls property the ash bed is at present only worked but as a fissure vein from 6 to 12 feet wide intersects this bed in the mine occasionally also this fissure vein is mined as it carries considerable copper.

It consists of a brecciated mixture of melaphyr fragments with a cement mass of Datolith calcspar and variable amount of silicious quartzose matter also Lammonite and analcime are common ingredients in the veins. This vein is naturally exposed in a ravine between the two upper shafts, it is said to have a north and south course. Its demarkation from the walls of melaphyr is very imperfect. It is a line of break in the formation, where the shattered portions next to the break are re-cemented by infiltration of minerals.

In this vein which lithologically completely corresponds with the cross vein opened in the "3" shaft (or B or 13) of the old Phoenix. The great abundance of Datolith in well crystallized form, partly colorless, partly greenish or copper colored is remarkable. It is intimately associated with calcspar but Prehnite is rarely present while in an amygdaloid belt about 200 yards northwest of the Ashbed belt, the Datolith, Prehnite and calcspar are invariably associated. The datolith appears to be latest formed as it covers the crystal bunches of the Prehnite.

Of the calcspar it is in some instances uncertain what relative age it has compared with the other minerals but other times it is surely older than the prehnite and datolith as the empty cavities of the shape of a dihexaetric spar crystal form the basis of the crystal groups of Prehnite.

Copper in minute grains is invariably sprinkled through these crystalline masses of Prehnite, datolith and spar, filling larger druse spaces of the amygdaloid and also the small amygdals. The rock is almost of flinty hardness, often the filling material of the amygdals has completely weathered out and the cavities are empty.

Friday June 15. Went to Northcliff mine 3 miles from Eagle River. The work now abandoned is done in the ashbed which there is intersected by a fissure vein of a hard silicious datolithic and prehnitic rock of whitish color partly of breccia structure and much of it very poor in copper. The vein strikes about north and south, is in places only a few inches wide and again 8 or 10 feet.

The ashbed there is a brown colored crumbly rock consisting of rough balls of amygdaloid cemented by a delessitic mass or by spar or principally by a stratified compact sandrock mass. It is to be considered as a breccia of amygdaloid and sandrock which during their formation were broken up and mingled in a magma which afterward indurated. The bed is generally not rich in copper except in local patches.

Some hundred yards northwest of it is a characteristic hard amygdaloid belt found everywhere in the district which has its large amygdaloid cavities filled principally with prehnite and sometimes also datolith, both of which are full of small nuggets and films of copper but I have not seen any place where regular mining was induced in these beds which are opened by many small superficial test pits. This rock is said to contain in some places much silver.

Saturday June 16. To Phoenix mine. The mine is worked in the amygdaloid beds, Below the bluffs. The high bluffs are composed of the so-called greenstone. The lowest beds are a black crystalline rock consisting of plagioclase and augite but the crystals are not well defined. The plagioclase with its lustrous cleavage is in dotted manner more free of augite than in other interstitial spaces which gives particularly on weathered surfaces a birdseye structure.

I went from top of the cliffs across the formation northwest and numbered the successive rock belts commencing with No.1 on top of the bluffs. The greenstone proper extends unto the creek which enters Eagle River at the ashbed of the old Phoenix. On the north side of the creek is a belt of grey amygdaloid. Then a wide melaphyr belt. Then succeeds the ashbed which is very wide and has as elsewhere a breccia structure. North of the ashbed in its hanging is a wide belt of fine grained black melaphyr very hard and compact. Beyond it succeeds the hard amygdaloid rich in prehnite druses.

In the afternoon I re-examined the outcrops in the river. Found the ashbeds to be a breccia of amygdaloid and sandrock, in parts of the belt one or the other predominating. At the Phoenix mine the ashbed is not less than 60 feet wide, probably more but only certain portions of this belt are copper bearing, others barren. I found an adit in the river bed near the footwall of the ashbed where the rock is seen to be metalliferous. It carries there besides copper also specks of silver in amygdaloidal cavities or in sparry seams of the rock mass.

Sunday June 17. Cliffs village on northline of Sec.1, T. 57, R.32. North cliff in Sec. 26 of Township north near south line of section. South cliff, shaft house new. No.1 near northline of Sec. 6 of T. 57, R. 31. No. 2 shaft 500 feet north on line of vein. New cliff is on another vein one mile east of old cliff vein. No.1 shaft 4300 from cliff bluffs. Bennets furnace is Sec.5 with copper in quartz vein.

Geological section from Klepetko, mining engineer at the Osceola. Beginning with base of cliff bluff under which the so-called slide is supposed position of Allouez conglomerate, from there the ground mined by the old cliff extends across Eagle River from bluff to creek horizontally, Distance 750 feet. From creek to most southern shaft 1000 feet, all this ground connected by drifts. 7 perpendicular shafts on this interval. About 30 different strata sunk through in this ground, an alternation of melaphyr and amygdaloid beds.

Deepest shaft 1600 feet or over from top of bluffs. Shaft at the base of bluff about 800, being with its bottom in the same stratum as the other deep shaft. Shaft across the road about 400 being according to the stratification about in the same stratum as the others.

750 feet south of southern shaft diamond drill hole 148 feet deep goes through amygdaloid and then black trap belt, upper part coarsely crystalline. 750 feet further south another drill hole inclined so as to be vertical to the dip 365 ft. deep, sequence of strata from above; amygdaloid then trap, five times alternating belts. From here 325 feet south shaft No. 2 of New Cliff going through the second melaphyr and 3rd amygdaloid belt of former drill experiment. Shaft No.1 is 400 feet further south commencing in the 4th melaphyr belt and penetrating the 5th amygdaloid belt. From here 1000 feet south not explored. Then another drill hole 262 feet deep commencing in trap and crossing 4 different belts with interposed amygdaloids. Drill holes vertical to dip. Bottom of shaft is in a conglomerate about 2 feet wide, no copper.

200 feet further south another drill hole 361 feet deep which crosses the same strata as former and under the conglomerate and amygdaloid and then trap belt. 325 feet further south drill hole 328 feet deep commencing in a trap belt above the conglomerate and then piercing two trapbeds and 3 amygdaloid belts.

600 feet further south drill hole 266 feet going through various modifications of melaphyr. 300 feet further south drill hole 296 feet going first through drift then amygdaloid supposed to commence at the floor of the next former drill hole and then through several trap and amygdaloid belts.

A further and last drill hole is 300 feet, still further south but barely touches the trap rock. Above is deep drift. At the bottom of the first of the drill holes a thin seam of jasper is struck which is supposed to be the analogue of the Calumet conglomerate. Those drill holes south of each other are not all in one straight line.

Sunday June 17. Went with Mr. Brockway over the grounds of New Cliff mine south of the road. Observed the different alternating outcrops of amygdaloid and trap belts of which the above notes from the maps of the mine give special information. The new mine is on a fissure vein striking across the formation about a mile north of the cliff vein but about parallel with it.

South of shaft No. 1 are several pits opened in amygdaloid belts which carry some copper and silver, prehnite quartz and calcspar, sometimes also epidote and delessite fill the amygdules.

The second belt of melaphyr cropping out south of the shaft a few hundred yards distant resembles very much the greenstone of the cliff bluffs. It contains numerous parallel narrow bands of a lighter colored somewhat greenish rock consisting of well defined plagioclase and augite crystals like the coarse grained greenstone. Descending down to the creek and ascending the opposite hill slope Mr. Brockway showed me some exploring pits in which a quartz vein with calcspar and some sulphurete of copper are the associated minerals. From here northeast on Mr. Bennets farm in Sec. 5 is another similar quartz vein which is richly loaded with grey copper ore. The vein contains there occasionally some crystals of violet Fluorspar. Stayed over night with Mr. Brockway.

Monday June 18. Heavy rain but nevertheless went to No. 2 shaft of New Cliff and descended to see the fissure vein exposed. The vein is at the bottom of the shaft (at 125 feet depth) about 6 feet wide, a brecciated mass of brown amygdaloid cemented by spar and prehnite seams, full of disseminated copper in a heavy solid network of films which in places form solid masses of copper from 10 to two or three hundred pounds in weight. The general appearance is very promising and (out) of the shaft without drifting a good many tons of mass copper have been extracted besides a large amount of stamp rock full of coarse copper. The vein seems to be much poorer in the solid melaphyr than it is in the amygdaloid belt underneath.

The amygdaloid struck in New mine shaft No. 1 next to surface is supposed to be an equivalent to the Osceola amygdaloid by the maker of the above map. Distance from greenstone belt (vertical measurement across strata) to jasper bed supposed to be equivalent to Calumet conglomerate, 1290 feet. From there to the supposed equivalent of Osceola amygdaloid 532 feet, vertical measurement of strata. From there to supposed Kearsarge conglomerate 810 feet of which the upper 44 (or 440 or 448) feet are unexplored ground. The lower are penetrated by drill hole 262 feet deep. Total distance of Kearsarge conglomerate from base of Cliff Bluffs or supposed Allouez conglomerate belt 1290 plus 532 plus 810 total 2632 vertical thickness of strata.

Toward evening the weather cleared up and Mr. Brockway took me back to Eagle River showing me on the way an exposure of the Allouez conglomerate belt on one of the greenstone bluffs about midway between cliff and Phoenix mine. The conglomerate is directly overlaid by the dark compact greenstone masses. Itself is only one foot thick but a plain conglomerate of the same nature as the Allouez conglomerate. It rests on a compact fine grained stratified silicio-epidotic rock about 3 or 4 feet in thickness which lithologically most resembles the pale greenish almost white mass filling the fissure veins of the neighboring country. It carries also some copper disseminated through its mass. It is perfectly conformable with the formation and reposes on a belt of dark amygdaloid. It is remarkable that neither at the Cliff nor the Phoenix mine this conglomerate and the associated strata have not been observed.

Tuesday June 19. Cold, windy and cloudy. Went to test pits of Phoenix east of the old location observing the character of the ashbed which is there about 60 feet wide. It has the same brecciated character as elsewhere and contains in nests considerable copper and some little silver in a dark amygdaloid with many datolith amygdules. Partly also in an earthy Brown amygdaloid footwall and hanging of the belt is a hard fine grained melaphyr. Heavy rain set in for the whole rest of the day and I had to return all wet. 50 cts for transportation of specimens from Copper Falls. Hotel bill for 9 days 18 dollars. Bought copper specimens 2.50, silver specimens 1.75.

Wednesday June 20. Went with stage to Calumet and then to Houghton. Expense 2.00 Found Dr. Kiefer there, had a pleasant evening with him. Received letters from home.

Thursday 21. Answered letters. Sent to washwoman (listed in German).

Went in the afternoon with one of the Columbia College assistants to Pilgrim Creek where he believed to have observed the discordant contact of the Lake Superior sandstone with the trap formation but it was simply an exposure of horizontal lake Superior sandstone with the exhibition of the false bedding I brought him then from there to the creek on Isle Royal property and showed him the contact of the Lake Superior sandstone with the trap.

Friday June 22. Have an opportunity to go tonight with a party to Isle Royal and will not let escape this rare chance so I remain at Houghton. During the day went to Allouez mine, examined the rocks incumbent on the Allouez conglomerate. The hanging of the conglomerate is a dark compact crystalline rock resembling the lower beds of the bluffs at the cliff mine and considered to be the equivalent of the greenstone. The belt is not very thick, perhaps 100 feet or less; above it follow amygdaloids and melaphyrs in alternation. The melaphyrs is distinctly banded in the manner of a stratified rock but the bands are evidently analogous to the bands perceptible in a lava or in slags of a furnace. In the melaphyr are sometimes dispersed blotches which have the character of an amygdaloid.

The succession of these alternating trappean beds is large, at least a half a mile wide. Further north towards the lake shore the stamp mill of the Allouez mine stands on the conglomerate belt which is believed to be the broad conglomerate at Eagle river. The footwall of the Allouez mine conglomerate is an amygdaloid melaphyr in various modifications extending south, part of the different belts projecting in bluffs facing the road and continued melaphyr and amygdaloid outcrops are visible south of the road.

The location of the Amic mine with its conglomerate belt is visible south of the Allouez mine from the top of the hill at a distance of about a mile. Returned with evening train. \$2.25 railroad and stage expenses.

Saturday June 23. The parties intending to go to Isle Royal postponed the trip. Went then to Delaware mine. Arrived at 4 o'clock in the evening. The exposures of the conglomerate in a belt from 25 to 30 feet thick are quite extensive. Close under the bluffs of black trap the representative of the so-called greenstone. Under the conglomerate is a large belt of grey amygdaloid which at the surface is in a somewhat decomposed and disintegrated condition. Expense for the trip 2.65 cents.

Delivered a letter of introduction from Hill to Mr. Davis the president of the company but saw at once that I would not receive any benefit from his acquaintance. He treated me so far with politeness but it was plain enough that he took no interest in my work and would not give any assistance.

Sunday June 24. Very cold and cloudy day. Went to Lake LaBelle, 5 miles distant. From Delaware mine on the road after crossing over to Helltown, Very few exposures can be seen. Sometimes a small knoll of melaphyr barely projects over the drift covered surface or by the excavation of the road some ledges of the rock became denuded. After reaching the divide of the watershed, in descending toward Lake LaBelle, rock exposures become more frequent. About 100 steps before the county road intersects the railroad track which is not yet finished a rather large conglomerate belt crops out in the road bed.

This conglomerate is very compact and epidotic and amygdaloid melaphyr pebbles are its principal components. Porphyritic pebbles are not so abundant as in other conglomerate belts. About 300 steps after having crossed the railroad, a very hard fine grained blackish melaphyr comes to the surface and forms bluffs on both sides of the road. Passing further on amygdaloids are seen exposed in alternation with melaphyr and with frequent local interruptions of the outcrops by drift masses. About a half a mile this side of Lake LaBelle to the left, a road leads off to the old mine of Lake LaBelle. In the ascent of the road, no exposures are seen until nearly the top of the hill is reached where a large body of the black fine grained melaphyr is exposed, dipping and trending in the regular direction of the formation generally, (nearly E. and W. trend, north dip).

Further on I came to 3 shafts standing in a direction at nearly right angles with the trend of the formation, indicating their course (source) to be on a fissure vein. The material thrown out is a sparry breccia of amygdaloid rock which contains some seams of copper ore. The wall rocks are an amygdaloid in the first two shafts. In the third and in the adit from a ravine a large conglomerate belt forms the wall rock and also the vein matter is there in part composed of fragments of the conglomeratic material. Mr. Hill told me these veins at the mine intersect a mass of syenite said to form the nucleus of the mountain but I could see no such rock thrown out at the mines.

This syenite I saw afterwards exposed in a quarry on the south slope of the same hill on which the old mines are opened but it is not a central forming rock nucleus of the hill as Mr. Hill represented it to me, but represents one of the conformably interposed layers of the Trappean rock series underlaid by various belts of amygdaloid and melaphyr, and lowest by a large belt of conglomerate which rocks are all plainly exposed in the bluffs sloping down to Lake LaBelle.

The conglomerate belt is best observable at the stamp mill side of the Delaware mine. In the higher part of the bluffs farther east the amygdaloid and epidotic melaphyr overlying it are well opened by a quarry and further to the east on the summit of the ridge precipitous cliffs are seen projecting which are the aforesaid syenitic rock, north of which the old Lake LaBelle mine is found on the plateau land.

Monday June 25. Went to Central mine. Followed the upper branch of the road. Saw several outcrops of the conglomerate near roadside. On the foot of bluff ere reaching Summit mine the conglomerate is laid open in a test pit. A very compact fine grained black trap broken up into shelly fragments forms the lowest ledges of the greenstone bluffs. Under it is a conglomerate bed 3 feet thick which rests on a grey amygdaloid weathered into a crumbly mass on the surface, other parts of the amygdaloid are dark green with many delessite amygdules.

Further on across a depression is the Madison mine which (is) worked in a fissure vein intersecting the aforesaid amygdaloids. The vein matter is a whitish green silico-prehnitic mass with copper disseminated through it in fine scales and in heavier masses.

Thence passed the Northwestern mine which worked a similar cross vein and came to the Central. At the Central the conglomerate belt is in the same way as above situated at the base of the greenstone bluffs of similar lithological character as before mentioned. The conglomerate is here much thicker, perhaps 15 or 20 feet and carries some copper. Under the conglomerate is an amygdaloid belt.

On the burrows I found many blocks of an epidotic conglomerate rich in copper which comes from a shaft that strikes through this conglomerate at a depth of 400 feet from surface, the vertical distance of the conglomerate from the Allouez conglomerate 665 feet. Conglomerate is represented in the plan of the mine published by Pumpelly which contains much copper disseminated through it. Collected a specimen of this trap which was yet in connection with a block of the conglomerate.

In a red amygdaloid of the burrows sometimes an abundance of analcim crystals are found. The same amygdaloid contains seams and large amygdaloidal spaces filled with blood red feldspar and partly with calcspar. In the rockhouse large masses of copper imbedded in calcspar or in calcspar and feldspar mixed or also in epidotic vein mass are seen in great quantities. The stamp rock is more of the prehnitic and epidotic and quartzose nature of the other fissure veins of that country.

The conglomerate in the mining map of Pumpelly is believed to be the Houghton conglomerate but since that time a third belt of conglomerate which is the epidotic conglomerate above mentioned, it is believed to be the equivalent of the Calumet belt and is struck at the 240 level. These both conglomerate belts have been opened by test pits south of the mine. The Calumet in a swamp across the creek.

Returned afternoon to the Delaware, examined there the conglomerate belt. Further east to the Pennsylvania mine where it is well exposed and has the same thickness as at the Delaware. Determined to return tomorrow to Eagle river and dispose of my specimens.

Tuesday June 26. Returned to Eagle Harbor. Stage 1 dollar. Afternoon re-inspected the formation along Eagle River. The strata on both sides of the river do not always correspond and are more or less faulted.

Met in the evening Mr. Brockway which promised after about two weeks to go with me to Copper Harbor. Found a large block of prehnite with datolith and calcsp^{er} loose in the drift. Packed box with specimens and made it ready for shipment (two boxes).

Wednesday June 27. Returned by mail stage to Houghton. 2 dollars. 50 cts cartage to Houghton.

Thursday June 28. With Mr. Wm Edwards, Oren, Blandin ectr. trip to the Porcupine mountains. Started 2 o'clock afternoon. Arrived at Ontonagon 8 o'clock. Stayed in port all night. Started

Friday morning June 29. Landed at Union Bay where the shore is formed by brown sandstones dipping under an angle of about 25 degrees north. Ripple marks abundant but no signs of organic remains. From here landed again 4 miles west of the foot of Porcupines. There similar sandstone alternating with conglomerate belts forms the shore. The conglomerate contains Porphyritic and Trappean pebbles besides (a) few of the lean ore formation of the Huronian. Ascending the steep hillside by a trail to the Carp Lake mines only sandstone and conglomerate outcrops are noticeable on the hight. The path leads over a clearing to the mines which are situated on top of the south slope above Carp River. Highest are bluffs of amygdaloid in which the mines are opened apparently following a fissure vein of brecciated calcareous nature underneath it a large series of brown sandstones all dipping under an angle of about 30° to the north.

In the valley and on the north slope of the following high hill range melaphyr forms the next succeeding belt, but the top part and south slope of this range is again conglomerate which is then again succeeded by a large melaphyr belt. These mines situated in the south half of Sec. 14, T. 51, R. 43 seem to have worked a calcareous fissure vein intersecting the amygdaloid trap and the underlying sandstone. The vein matter is a breccia of calcsp^{er} inclosing fragments of trap and sandstone, generally very little copper seems to be contained in the vein. Returned to camp on shore about near centre of Sec. 12.

Saturday June 30. Went with small boat along shore about 1 mile beyond Lone Rock, a small sandstone island, sandstone dipping north under an angle of 30 degrees and intersected by many narrow veins of calcsp^{er}. Also the shore all along this distance of 7 miles is formed of similar upheaved sandstone and conglomerate beds, some of which are nicely ripple marked or covered with mud crack moulds.

Near the centre of Sec. 21, R. 44 we landed and followed an old road up to abandoned mines situated at the S.E. corner of Sec. 25, T. 51, R. 44 in the same relative position as the above described mining locality is est on the south slope of the range beneath high vertical bluffs of melaphyr on top and sandstone below.

The copper is contained in hard epidote veins intersecting the melaphyr but the copper deposits are not rich. Ascending from the shore toward the mine the entire surface of the north slope of the mountains is formed of alternating beds of brown sandstone and conglomerates. The trap forms the hight of the ridge and beneath it are again sandstones amounting to a very large series of beds. The valley of Carp river is swampy in the bottom and shows no rock outcrops. A large beaver dam is hemming the river at the location in its free course. Lower down large falls are said to exist.

This first hill chain is about 1300 feet above Lake Superior. The second chain which we did not ascend is 1400 feet high. Returned to the shore and met the Steamer Estelle which brought us back to Houghton the same evening about 12 o'clock at night.

Sunday July 1. Received letters from home. Stayed all the previous rest of the night at the Douglas house as my room at Millers was occupied.

Monday July 2. Wrote home. Went over the hillside between Quincy and Hancock mine. There seems to be a conglomerate belt between the two mines as many large blocks of it cover the surface on an intermediate spot close to roadside. West of the Hancock are two distinct beds of sandstone and conglomerate opened by test pits. Intermediate are light colored amygdaloid traps which on the surface are in a soft crumbly decomposed sandstone. The Hancock beds resembles the ashbed of the Phoenix and Copper Falls mine but is not so distinctly brecciated as the former and consists principally of amygdaloid material of a brown color with aphanitic grain.

In the evening I went with Mr. Oppenhof, a farmer west of the Atlantic mine to his home. Stayed all night with him and came back with him.

July 3. at noon. In passing the northern shafts of the Atlantic I observed the brecciated nature of the copper bearing rock at the mine completely similar to the ashbed as I saw it at the old Phoenix mine. The conglomerate in the hanging of this bed I have already mentioned on a former occasion. Further west no more outcrops of any kind are noticeable. All the surface is deeply covered with drift.

July 3. Stayed afternoon at Houghton as it was not practicable to make any further excursion on account of the preparations for celebration of the 4th July.

July 4. Celebration of the day.

July 5. Went with stage to Rockland. 6 dollars fare.

July 6. Followed the creek which runs near the railroad depot. The bluffs are formed by red drift clay. In the bed of the creek I met first a belt of brown brecciated amygdaloid very similar to the ashbed of Keweenaw Co. Lower succeeds a compact melaphyr belt of considerable thickness beneath which a belt of brown sandstone about 60 feet in thickness is exposed and last under it is again an amygdaloid belt which downwards changes into a compact melaphyr. Rain compelled me to return. Rain all day and night.

Saturday July 7. Fine weather. Went to creek flowing along north line of Sec. 7 and 8. Found some exposures of melaphyr and amygdaloid but the exposures are limited and not much could be learned about the position of these belts. Afternoon went with Mr. James of the Minnesota to another creek flowing N.E. ward across Sec. 4, T. 50, R. 39. We found there first a large belt of conglomerate on the south side of a succession of grey sandstone beds amounting to not less than 800 or 1000 feet. Dip conforms with the rock of the country about under an angle of 45 degrees. Some resemblance exists with the sandrock of the None Such mine but no copper in it. North of this belt no trap rock is known.

South of it we crossed several belts of trap and amygdaloid. A trap belt on east side of road in N.W. $\frac{1}{4}$ of Sec. 9 is porphyritic. Within the extent of Sec 9, 5 or 6 conglomerate belts are known to exist in alternation with trap belts. Some of them are 50 feet wide, others 15 to 20. The conglomerate has some times in part the uniform nature of a fine grained brown sandstone.

Toward evening went to New Rockland mines on the row of trap bluffs south of the Minnesota range. There are several mining shafts sunk south and a part north of the melaphyr bluffs. The southern apparently in a dark reddish brown amygdaloid with calcspar and red feldspathic seams. The northern shafts hoisted a quartzose yellowish green epidote rock but in neither of these beds copper seems to occur in paying quantities.

Sunday July 8. Went over the hills intending to strike the creek passing the old Rockland Stamp mills but came to far north and descended to the Flint steel River. Saw no outcrops of larger extent except some amygdaloid and melaphyr exposures here and there found in isolated patches. Toiled my way up the creek through thick underbrush until I struck the road from Rockland to Maple Grove. Returned about 11 o'clock forenoon.

Monday July 9. Went by R.R. to Ontonagon 1 dollar. Made arrangements with Mr. Mitchell to go with him to his explorations S.E. of Lake Gogebic a week from next Thursday. Returned in the evening. Intended to go to-morrow with a man to the south trap range on the headwaters of east branch of the Ontonagon but the fellow backed out.

Tuesday July 10. Went with the hotel keeper, Mr. Chynoweth per buggy to the Bohemian mine. Met Mr. Brand the agent in his office and were very cordially received and invited to dinner which invitation we accepted. The mine is opened partly on the south side of the bluffs in the Ogma vein which is a rather soft greyish amygdaloid containing much epidote like the rock of the Adventure mine. It is well loaded with copper in barall work(rock) and in stamp rock. All the material hoisted is intended to go through the stamp mill.

Another shaft is lately opened on the northside of the bluffs in the Piscatawa vein, likewise an epidotic amygdaloid rich in coarse copper. I descended into that shaft so far 120 feet deep. On the incline of about 35 degrees dip, a rich string of copper is visible in the middle of the vein, but also above and below the vein mass contains a fair proportion of the metal.

Further north is the Knowlton vein equivalent with the Mass mine and still further north on the hills of the opposite side of the valley the Minnesota vein with its underlying conglomerate bed is found. At the different burrows of the Bohemian fine druses of stilbite ? calcspar and epidote can be found. The amygdaloid surrounding them is soft, brittle, earthy. Prehnite occurs also but not abundant, but the soft green fatty mineral with smooth fracture which in other mines as in the National frequently occurs with the copper bearing sparry seams is also here common. Returned to Rockland at 4 o'clock.

Wednesday July 11. Went to falls of Ontonagon on west branch. Passed the Forest mine where I turned south on a road leading to the falls. From the mine several belts of melaphyr are intersected which amounts to about 1000 feet. The last belt forms abrupt high bluffs toward the river and south of them drift masses adjoin it which in the deep ravines are not cutting down to solid rock ledges but close by the river the horizontal silurian sandstones become largely exposed in the river bed. A great abundance of pot holes are carved into the sandrock.

Diagram

Handed to Mr. Chynoweth 100 dollars in gold, 50 dollars paper note, total \$160. Bought camp implements 2 dollars. Victuals 5 dollars.

Thursday July 12. Left with a man for south range. Daily wages of man agreed for 2 dollars. Left at seven in the morning. From yesterdays rain the grass and bushes were all wet and we got soaked through in the first start. Then crossed the river by wading and short distance after had again to wade the south branch. Then followed an old supply road on the east side of the south branch which was also overgrown with high grass and underbrush. 9 miles from Rockland crossed a deep ravine in which silurian sandstone was exposed in the bed of the creek but this is the only spot where rock could be seen on the whole days route. The road was frequently obstructed by windfalls and was very hard to follow. 14 miles from Rockland in the south part of T. 49, R. 38 is a great windfall over a mile wide which is difficult to pass.

Then we struck an old road again, crossed into Town 48, R. 38 where we camped in the north part of Sec. 10 marked on the map as pine plains, but near camp is mixed timber and a creek flows through a deep ravine eastward to the east branch. We arrived there at 5 and was completely wet and had to dry our things with the help of a large fire. At seven the sun came out and we expected fine weather for the next day but in the morning it rained again so that we could not continue our voyage the end of which I estimated at least 16 miles off over a very rough country. Night very cold which hindered us from a sound sleep.

Friday July 13. Remained in camp unto noon and as no prospect for clearing up ~~seem~~ to exist I determined to return and came about 6 miles to the place where we took dinner the day before. Mosquitoes were plenty but we managed to drive them off with smoke and kept the tent clear of them.

Saturday July 14. Cloudy and rain during the forepart of the day. We left camp at 7 and arrived in Rockland at noon traveling through the grass and underbrush we got wet right in the start and subsequently wading two branches of the river, the soaking was made perfect. Paid the man six dollars and gave him the remainder of the grub. Found letter from home. Telephoned to Mr. Mitchel but got no answer that evening.

Sunday July 15. Bright sunny weather. Followed the railroad track northward for about one mile or more. Most of the surface is covered with loose material but in several places the rock has become denuded by the excavation of the road. Several belts of dark almost aphanitic melaphyr are seen in alternation with amygdaloid belts and belts of sandstone. The amygdaloid is in two of the exposures of brown color and has a brecciated structure very similar to the ashbed of the old Phoenix mine. Further on again hard melaphyr succeed and several sandstone and conglomerate belts are lastly intersected by the road bed about 1½ miles from Rockland. The rock disappears on the road for all the distance to Ontonagon.

Mr. Mitchell send word he will be ready to start for Gogebic next morning.

Monday July 16. At Ferrisons, The Windsor mine is located. Next west to it is the so-called Trap mine, then comes the Norwich. In all of them the copper occurs in epidotic seams. At the Trap mine the shafts are sunk on top of the bluffs. At the Windsor and at the Norwich a conglomerate belt is found at the base of the bluffs. The river and a wide belt south of it seems to be in a Silurian sandstone area. Mr. Mitchell informs me that somewhere southeast of Ferrisons on the south side of the river one of his friends found large ledges of limestone full of fossils but he could not indicate the exact spot.

Monday July 16. Went in the morning with a two horse wagon toward Lake Gogebic but as it rained all forenoon and the road was in awful condition we stopped over at Fergusons unto next morning. Thunderstorm in the afternoon.

Tuesday July 17. Left Fergusons with wagon. The road to Lake Gogebic is in undescribably bad condition and to my surprise horses and wagon stood the trial of going over it. We arrived at the lake towards noon, took dinner there and left with two row boats. The lake was very rough and we had to keep close to the shore on the wind side to avoid danger as the same boats had capsized the day before in a squall. Arrived about 5 o'clock at Gillis landing and camped there.

Wednesday morning July 18. Left with our boats at 6 o'clock in the morning and safely landed about 8 on the east shore of the lake about $\frac{1}{2}$ a mile from the inlet of Gogebic river. Followed a trail in S.E. direction which leads to the exploring pits of Mr. Mitchell. The camp of Mitchell is at the north line of Sec. 13 short distance east of the $\frac{1}{4}$ post, the pits are partly in Sec. 12, partly in 13, west of the $\frac{1}{4}$ post.

Further north is a belt of sub-schistose diorite which perhaps more appropriately might be called a quartzose hornblende schist. It forms a natural outcrop amounting to a belt about 100 feet wide, dip south under high angle. On its south side follow well laminated schists of silky shining hydromicaceous character and of dark lead color. Then comes a large succession of banded and considerably corrugated quartz schists, part of which are prevaillingly quartzose. Another part consists of alternating linear seams of quartz with seams of a micaceo chloritic soft fatty feeling schist. Further S. the schist forms a belt of soft chloritic hydromicaceous character with only occasional subordinate concretionary seams of glassy white quartz which ledges are impregnated with various proportions of octahedric iron oxyd crystals.

Other strata of this horizon are a silicious iron ore of metallic lustre. These beds occupy a depression and are covered with drift. Further south a row of cliffs naturally projects which consist of well laminated hydromicaceous quartz schists partly dark green colored by chloritic constituents and in some layers copiously disseminated with red garnet crystals. Other layers are prevalently composed of silver greynactinolite which is accompanied with a smaller or larger percentage of octahedric iron ore crystals. This garnetiferous and actinolitic rock belt is locally associated or also forms the hanging wall of a tolerably rich silicious iron ore, banded in its structure by alternation of thin seams of rich ore with highly quartzose leaner seams of ore. All these beds dip regularly to the south under a high angle. The entire series of rocks described is exposed naturally in part and in part laid open in test pits. Total thickness of series seen about 800 to 1000 feet.

Afternoon followed the dioritic belt N.E. ward across the creek. Came back on it to the test pits. Went across the formation. 1. Next to diorite silky shining lead colored slates 50 or 60 feet. Then micaceous quartz schists banded and corrugated. Then silky shining lead colored slates harder than the first and very silicious besides impregnated with iron ore chloritic hydromicaceous garnetiferous rock connected with it. Then actinolitic quartz schist rich in octahedric iron oxyd and garnets large belt. Further south hydromicaceous lead colored schists, again a broad belt. Further south after considerable interruption of outcrops a well laminated but compact hornblende rock similar to the dioritic rock on the north side of the described series.

The only place where iron ore can be looked for is between the actinolitic quartz schist and the quartz schist belt further north.

Thursday July 19. Fine weather. Left camp at 7 o'clock. Went to creek which comes out of a little lake on the east side of Sec. 13. Creek full of large boulders. Followed creek and found a large belt of porphyritic hornblende rock associated with hydro-micaceous schists crossing the creek on east line of Sec. 12, about near the $\frac{1}{4}$ post. This belt may be a continuation of the belt of hornblende rock north of Mitchells test pits in Sec. 13. Further down the creek no more outcrops but the surface of the low lands on both sides of the creek are covered with an abundance of boulders a large proportion of which belong to the copper bearing series.

Crossed creek in the north part of Sec. 7, T. 46 R. 41 and followed a road cut by Mr. Mitchell. Crossed another branch of Trout Creek near the N.E. corner of Sec. 31, T. 47, R. 41 and found one low ridge near the N.W. corner of Sec. 32 of the same town an immense angular block of epidotic melaphyr inclosing heterogeneous light-colored reddish rock masses of a somewhat laminated structure. This block seems to be a loose mass about 20 feet high, 40 feet wide and 15 feet thick.

On the surface of this knoll and in the surrounding lowlands are a great many other smaller blocks of melaphyr from 1 to 4 tons in weight but the rock is evidently not in place but from its angular form I presume that the mother ledge cannot be far off. This knoll is visible from the Lake Gogebic appearing to be about 1 or 2 miles east of the mouth of Trout River, a branch of which flows close by its base. Returned from there to camp. Mosquitoes terrible today.

Friday July 20. Rained in the forenoon. Afternoon clear weather. Went to Lake on east line of Sec. 13, T. 46, R. 42. Found some rock bluffs on the west shore of the lake and on the opposite shore corresponding outcrops of much larger extent. The rock is a massive diorite-like rock, some coarsely crystalline, other portions minutely crystalline in structure. A part of these rock masses is distinctly laminated. Schistose portions of these schists green and white speckled by segregation of white feldspathic streaky masses. In certain other portions of the schistose rock hydro-micaceous silky shining material forms a large porportion of the rock. This rock belt is about $\frac{1}{4}$ of a mile south of Mitchells mining pits and can be traced from the lake to the west part of the section.

Saturday July 21. Left camp at 6 o'clock, landing at 7 with rowboat. Landed at Gillis Warehouse and then went on to outlet of lake where we arrived about 1 o'clock afternoon. The man with wagon which promised to be there did not come but toward night another wagon arrived from Ontonagon. We stayed all night in the camp and left

Sunday morning July 22 at 6 o'clock. Arrived at Ontonagon at 4 o'clock. On the way from the landing about 1 mile distant are bluffs of a reddish colored trap. See specimen. Then after leaving Norwich mine about 4 miles north the road crosses another melaphyr belt of red color of which I collected 4 specimens. Further on no more outcrops. Left my pack at Figelow House and went in evening back to Rockland with railroad.

Monday July 23. Went afternoon to National mine where Mr. Parnell gave me a large piece of datolith from themine. At 4 o'clock went with train to Ontonagon. Hotel bill 16 dollars. Paid to Mr. Mitchell 6 dollars for ride from Lake Gogebic. Railroad fare 1 dollar.

Tuesday July 24. Left Ontonagon in company with Mr. Beaser per wagon to Iron River. The road follows closely the shore and is all located on a sandy low ridge of the beach. About 4 miles from Iron River red sandstones locally crop out, they dip under a low angle northward. On Iron River a large exposure of reddish grey sandstone is right at the mouth and higher up the stream a very large succession of slaty grey colored arenaceous layers succeeds. From the strike of the strata I infer the sandstone outcrops at Union Bay to be lower ledges and the quartz rocks containing silver at Iron River according (to) this suggestion must be next above these sandstones. Mr. Beaser tells me that he observed this fact all over the country which is well known to him from frequent exploring trips he made over this ground.

Went to Union bay and then returned to road leading to the Union mine. Short distance before arriving at the Union mine in the creek brown sandstones dipping northward are disclosed and further on outcrops of the same sandstone show it to be a very large belt under which a dark green chloritic amygdaloid belt is situated which is the copper bearing belt of the Union mine. The footwall of this amygdaloid is a conglomerate belt. Mr. Beaser informs me that a large compact trap belt overlies the first mentioned sandstone belt which latter sandstone he identifies with the large sandstone belt forming the footwall of the Carp Lake mine.

From the Union mine we followed the road to the Non Such 3 miles distant. There we see the formation extensively displayed in the bed of the creek. The strata strike northeast. The dip is southeast under an angle of 31degrees. The ore bearing rock is a partly conglomeratic sandstone of greenish gray color. Under it follow dark grey slaty beds and lighter colored coarse sandy beds with black graphitic slaty seams covering the layers just the same as the silver bearing rock of the Iron River which is identical with it. Lower down follows a large series of finer or coarser grained sandstone layers and further downwards Mr. Beaser informs me a large trap belt succeeds.

This same series of rock Mr. Beaser observed about 5 miles west of Black River and at the mouth of Maple River at the lake shore dipping northward there. In the hanging of the Non-such copper bearing ledge is a large succession of grey slaty fine grained arenaceous rocks just the same as those exposed in Iron River. The beds at Iron River however dip northward. According to this there exists between the lake shore and the Non Such mine an anticlinal axis

Wednesday July 25. Left Union mine at seven o'clock. Followed an old road which leads to the Stamp mills of the old Carp Lake mine following the north slope of a high ridge. Found at the head of the Union River a small lake in Sec. 20 in which several large springs are seen in the bottom of the crystal clear water. Thence we **Went** on to the tributaries of Carp River and followed one of the principal branches up to the top of the ridge. Where the road crosses the stream are no outcrops but some distance upwards we found first a large belt of a hard compact conglomerate dipping north. Under this a broad belt of trap which all through its thickness is of amygdaloid nature with epidotic amygdules follows, but the lowest beds of the above mentioned conglomerate are more of the nature of a compact flinty sandrock of fine grain, probably by alternation induced by the contiguity with the trap.

The non-amygdaloid portions of the trap belt which amounts to about 200 feet are a fine grained reddish grey rock. The creek makes at the place where the lowest beds of the trap rock are exposed an almost rectangular turn and the underlying belt of a second conglomerate belt strike almost north and south and dip eastward.

The creek runs for a while with the strike of the strata just on the division line between the overlying trap beds and the conglomerate which like the first belt is very hard and compact. Beneath it follows another large series of traprock, most of them are red colored and partly amygdaloid with quartzose-epidotic amygdules. Lower still are red jaspery looking trap rocks following each other in large succession. At one place this rock forms falls about 20 feet high. This red rock continues to the height of the mountain, the top of which is occupied by a large beaver meadow.

We returned from here to the road and went to Carp Lake Stamp mills but found a large windfall had obstructed the road to make it totally impassible. After long tedious work we finally succeeded to overcome it. At the river we could not find a boat to cross it and had to wait until Mr. Lockwood and his man arrived at the other side and built a raft which brought us over as we had no provision with us. We camped near the house left of the Old Carp Lake mine as the only remainder of former structures of this location. The sandstone belt of the bluffs below the mine is said to have been measured and found to be 500 feet thick. Under it in the valley a large amygdaloid belt succeeds.

Thursday July 26. Early in the morning a thunderstorm came up and rain which impeded us from doing any work this morning. Toward noon we decided to return to Union Bay. Broke up camp and arrived there about 2 o'clock. From there Mr. Beaser and I walked to Union mine where we made headquarters in a barn filled with straw. Examined the strata exposed in the river and found the statements made by the mining captain to me to be erroneous.

The copper is found in a dark delessite amygdaloid full of slicken-faces which is overlaid by fine grained compact conglomeratic sandrock which makes part of a sandrock belt several 100 feet in thickness well exposed in the river bed. The footwall of this copper bearing amygdaloid I was informed to be again a conglomerate rock but the amygdaloid is succeeded or makes part of a melaphyr belt several 100 feet in thickness and partially of amygdaloid character in several horizons of the belt. Subsequently however we see this trap belt in the river overlying another belt of very hard red sandstone of fine grain and amounting to a succession of beds over 150 feet wide as far as I could see the exposures.

Friday July 27. Fine weather. Went from Union location S.W. over a rather plateau-like country with no outcrops until we struck a range of high hills situated in the sections 4, 5 and 6 of T. 50, R. 43, and represented to me by Mr. Beaser as consisting of a porphyritic rock which resembles the porphyritic pebbles of the conglomerates of the copper bearing series and which he supposes to underlie the copper bearing series so as to be the centre of an anticlinal axis from which the strata dip north and south. The next overlying rock to the porphyritic is said to be a red jasper-like rock.

I found these hills mainly composed of a hard altered sometimes jasper-like red colored sandrock in connection with a hard conglomerate which in places is of finer grain and of breccia structure almost entirely porphyritic, other times consisting of coarse lumps of amygdaloid trap mingled with the arenaceous conglomerate mass.

I did not see an exposure of trap in these southern hills and the altered red colored sandrocks although the rocks are close under the surface; at the south slope of the ridge I could not ascertain whether their dip is south or north. They are full of cleavage cracks irregularly intersecting each other.

No well shaled hand specimens can be hammered out of the larger chunks. Returned in the afternoon to Union location without having accomplished to ascertain the statements of Mr. Deaser. Obtained on my return from the miner at whose house we took our meals several specimens of the White Pine mining location 2 miles east of the Non such. The rocks in both places are totally identical.

Saturday July 28. Returned with stage to Ontonagon. Mr. Mead informs me that all the copper ever found at the Carp Lake mine was found in the uppermost portion of the sandstone underlying the amygdaloid. He also informs me that south of Carp Lake the strata do not form an anticlinal axis but dip all regularly to the north. The porphyry spoken of by Deaser is not found on the south slope of the observatory hill but conglomerate and trap beds. The porphyry is the lowest stratum of copper bearing rocks seen and is found in the valley south of the south range at a lower level than we descended to. Mr. Mead showed me boulders of conglomerate very rich in copper which were found on the slope of this south range of the Porcupines.

Sunday July 29. Retrospect on last weeks observations with regard to the strata seen exposed near Iron River and near Union Mine. Their trend is northwest, their dip northeast. The brown conglomeratic sandstone exposed at Union dock underlies the grey slaterock series of Iron River. On Little Iron River the brown sandstones dipping N.E. are seen well exposed near the bridge and south of it. Further south at the Scranton mine are exposures of the grey slates and of the Non Such Strata but these dip south and are in anticlinal position with the gray slates of Big Iron River which dip N.E.

East of Iron River for several miles along the shore brown sandstones dipping under a low angle of about 20 degrees N.E. are exposed on the roadside. These overlie the grey slates of Iron river which latter can be further south observed conformably succeeding beneath the sandstone. This sandstone appears to me connected with the horizontal silurian sandstone strata exposed on the east side of Ontonagon by uninterrupted succession of the beds gradually losing their dip.

The greater part of the large boulders forming the shore line of Lake Gogebic are porphyry of the same kind as the porphyry found in a large belt outcropping on the south side of the Porcupine Range. They are too large to be considered as pellets of disintegrated conglomerate beds and beyond doubt are waterworn fragments originating from the Porcupine Range transported there by drift action. Boulders of this brick red colored quartzose and feldspathic porphyry of subangular form and 4 to 500 pounds in weight are frequently met with in the vicinity of Rockland. Also near Marquette I found them. The rock forming the shoals at Stannard lighthouse is a porphyry of this kind.

Monday July 30. Returned with stage to Houghton. Arrived 6 o'clock in the evening. Fare 6 dollars. Day fine. After 6 heavy rain and thunderstorm all night.

Thursday July 31. Fine weather. Evening and night severe thunderstorm and rain.

Wednesday Aug. 1. 3 pr. socks, 3 collars, 2 shirts, one handkerchief sent to washwomen. Received letter from home. Bought map of Lake Superior by Farmer 1.75. Went afternoon with Mr. Hill to see Capt. Vivian of the Franklin. Inspected the mine which is now producing 120 tons of copper monthly. The surface work of this mine is kept in admirably good order.

Saw this time the pits in which the Houghton conglomerate is exposed. 400 feet east of the shaft in which the Fewabic mine opened the Albany and Boston conglomerate from which the cross cut to the Fewabic or Quincy lode commences.

Thursday Aug. 2. Thermometer 60 at noon. At night rain. Wrote to Governor. Paid hotel bill up to Aug. 1, 12 dollars. Sent letter to Governor and to Erockway.

Friday Aug. 3. Wrote home. Went with Mr. Ryan in his carriage and in company of Mr. Hill to Ryans' mine and to the old pits in the vicinity in which in former days large masses of Whitneyite (ars. of copper) were found. Weather clear.

Ryans copper bearing belt is about 7 or 8 feet wide, amygdaloidal trap of reddish brown color with copious spar veins, some of which are inclosing a band of grey copper ore. The copper is in heavy nodular masses dispersed through the amygdaloid, often enveloped with spar. The proportion of the copper to the rock mass is larger than I have seen it in any other mine. The shaft is at present 95 feet deep and on both sides about 20 feet long drifts are commenced which everywhere exhibit the same richness in copper nodules, some over 100 pounds.

Test pits along the belt are opened for 7 or 800 feet and I have in every instance struck the same rich amygdaloid belt. The hanging of the amygdaloid is a fine grain-ed reddish trap. Beneath the main copper vein, copper continues to be found in paying quantities for the space of about 36 feet in all.

West of Ryans mine on a creek passing his camp are old test pits, the furthest ones opened by a man named Miner. His shaft is sunk through a fine grained grey colored rock with dull smooth fracture which contains spar and siderite seams carrying a little copper. In other pits some distance further down the stream a brown amygdaloid is uncovered which resembles much the amygdaloid of the Ryan mine but is another belt in this amygdaloid. Formerly large masses of Whitneyite were found but I could not find any of it on the spot. West of Miners shaft is again an amygdaloid belt. Returned to Houghton.

Saturday Aug. 4. Wrapping paper 50 cts. With Calumet railroad to Osceola and Tamarack shaft in company of Mr. Hill. Tamarack shaft is at present 850 feet deep. Last stratum an amygdaloid, (See specimen) above a belt of hard trap beginning at 799 feet consequently about 50 feet wide. Between the Allouez and 799 various alterations of trap with amygdaloid in seams not much exceeding 6 to 10 feet. The different beds below the Allouez are generally not carrying much copper. Osceola mine produced last month 200 tons of copper.

Section of Wolverine mine.

Saw in Mr. Daniles collection an oval nodule of copper twice as large as a goose egg with a large cavity in the interior lined with crystals of copper.

Diagram

Quincy mine produces monthly 300 tons of copper.

~ Sunday Aug. 5. In the bluffs close to Quincy Stamp mill by digging for material to fill in under the dock, a large bed of well stratified fine sand has become uncovered which evidently is a recent shore deposit. This sand accumulation is covered by masses of coarse boulder drift, the transportation of which consequently must have occurred subsequent to the deposition of the sand.

Diagram.

Laundry list in German

Wm. Schmidt , Delaware. Good woodsman and boatsman

Monday Aug. 6. Went to Calumet and thence to Cliff mine. Dined with Mr. Brockway and went after dinner to his new find N. of the old cliff, not far off from the ashbed belt of old Phoenix, about 300 feet south of the belt where a fissure vein crosses the amygdaloid belt which carries a good quantity of copper in small masses and in disseminated finer films. The vein as far as denuded is about 3 feet wide consists of Prehnite, datolith, quartz and calcspar. The quantity of copper found in the small opening is quite large. As it is opened close under the surface much of the copper is oxydized. The vein can be traced so far to its intersection of the ashbed.

Accepted invitation of Mr. Brockway to be his guest. Made the acquaintance of his daughter, she lately pronounced Dr. of Medicine. She is intelligent lively and rather enthusiastic in her expectation of professional medical life.

Tuesday Aug. 7. Bright fine morning but cold. Went to Delaware escorted by Mr. Brockway. Inspected the natural exposure of the cliff vein at the bluffs which shows it to be a fissure filled with broken fragments of the greenstone retaining in a degree their natural position in which the hollow interstices were after the upheaval filled with the vein matter by infiltration.

Diagram

Afternoon with stage to Delaware. Central mine produced last month 83 tons.

Wednesday Aug. 8. Went after breakfast to Helltown to engage a man for the next 8 or 10 days but could not find one. Returned to Delaware and hired Wm. Schmidt, a laborer of the mine with permission of Mr. Davis. Bought victuals for the trip. 6 dollars. Went then on an old road over the greenstone belt northwards towards Eagle Harbor until I came unto the large conglomerate hills forming the second belt from the lake shore. The conglomerate is underlaid by a large belt of trap which is amygdaloid in the upper part. Between the greenstone and this trap various other belts of trap and amygdaloid can be seen in outcrops. Also the so-called ashbed is noticeable but no mining is done in that vicinity of that road I went. Returned to Delaware at noon. Schmidt engaged at 2 dollars per diem.

Thursday Aug. 9. Hotel bill and wagon to Aetna mine 6. dollars. Started at 8 from Delaware, with Pasage, Schmidt went a foot . At the Aetna location we camped in one of the vacant houses. After dinner examined the mine which is at the base of the north slope of the greenstone range. The rock of the burrows is a coarsely crystalline diabase like the rock which I collected last year at the Clark mine.

It forms the upper strata of the greenstone belt. The greenstones exposed further south are dark mottled with glistening dots like the greenstone at the Cliff or Delaware mine. On the south slope of these greenstone bluffs beneath the greenstone a cupriferous conglomerate belt is seen in the various mining locations of the south slope. Under the conglomerate is a cupriferous amygdaloid but the mines generally were opened in fissure veins intersecting these amygdaloids, the conglomerate and the greenstone.

By going south from the Aetna mine following a good road we come on the other side of the range to an old wood road leading east along the slope to the abandoned Manitou mine. From there about 1 mile east we find the old Montreal mine in which a fissure vein is mined which intersects the greenstone, the conglomerate and the amygdaloid in the different shafts of the mine.

A $\frac{1}{2}$ mile further is the Star mine which has various shafts quite remote from each other. In the eastern shafts a hard amygdaloid containing considerable copper is mined which partly occurs in the amygdaloids, partly and principally is contained in quartzose prehnitic seams analogous to the fissure veins. But coarse copper is not abundant in this vein material. Most of it occurs in very minute scaly particles.

The veins contain frequently also Limonite and calcspar, seams rarely carrying copper from the eastern pits of the Star mine which are near the falls of Montreal River. We returned along the south slope of the greenstone bluffs. Saw the conglomerate belt beneath in one place largely exposed in cliffs. In another place a shaft was sunk into it but copper is not found in paying quantities in this belt of 25 to 35 feet in thickness.

The road from the star mine crosses afterwhile the summit of the greenstone range and follows the north slope on its western extension. It passes there a shaft of the Clark mine. Further down the hill amygdaloid trap is seen exposed and then a belt of ripplemarked brown sandstone succeeded further on by an overlying amygdaloidal belt.

Returned to camp on Aetna location. At the houses between the barn and the old schoolhouse a belt of amygdaloid in brecciated intermixture with arenaceous masses is exposed which in all probability is the equivalent of the ash bed of Eagle River country.

Friday Aug. 10. Fine clear weather, but a catharr in nose and throat makes me feel somewhat unpleasant. Started after breakfast for Mount Houghton. A good road leads from the Aetna to the Cape mine, an old abandoned mine on the south side of the greenstone range. And from there a lumbering road is cut which strikes the Montreal river near the $\frac{1}{4}$ post between Sec. 13 and 14. After crossing the river we followed this Sec. line southward to the top of Mount Houghton but did not find any corner or $\frac{1}{4}$ post on this line. On the way near the summit I found an exposure of melaphyr but on the real summit no rock exposure is seen and the high timber prevents any view on the surrounding country. I desisted from following this section line further south as it leads into a large swampy depression which extends down to the lake shore. Returned to Aetna on the same way I came. Arrived about noon and did not go out any more that day.

Saturday Aug. 11. Intend to go to Keweenaw point about 10 miles distant from the Aetna. On the Aetna location north of the ashbed belt an alternation of melaphyr and amygdaloid beds is exposed which forms in the aggregate a very wide belt.

Started at 6 o'clock in the morning. Went to Clark mine at which the ashbed belt is again visible near the houses. From here an old road to a camp on Silver creek, thence passed over a greenstone ridge where some old mining shafts are under the greenstone bluffs, old Lake LaDelle mine, thence about 1 mile further is the Keweenaw mine, also on the south side of the bluffs. From here to the lake shore a distance of about 4 miles the old road is very bad, almost obliterated and obstructed by beaver dams and windfalls.

At the lake extensive exposures of melaphyr and amygdaloid dipping under a high angle northward. The melaphyr and amygdaloid are often intermingling in irregular masses and a great many prehnitic and lammonitic veins of small size intersect them all of which carry a small amount of copper.

Under the trap comes out a large body of a jasperlike banded red or red and whitish mottled rock, or the rock is in the form of a non-stratified massive breccia full of small amygdaloid like cavities filled with prehnitic or sparry and silicious mineral. This rock seems to me analogous to the sandstone belts and conglomerate belts alternating with the trap but it is very much altered and approaches sometimes the red porphyry of the conglomerate pebbles. This jaspery rock crops out for about a mile along the shore west of Union Bay, about in Sec. 20, T. 58, R. 27. It is apparently identical with the jasper rock on the south range of the Porcupine Mountains. Built a hut on the lake shore for the night as it was raining in the afternoon.

Sunday Aug. 12. Went along shore up to Fishing station in Union bay. All along outcrops of various kinds of trap often intersected by small prehnitic and cupriferous veins. Some of the trap also inclosed fine nodules of Thompsonite. Thence returned to camp and followed the shore toward mouth of Montreal river. A large belt of brecciated jasper is interstratified with the trap. Then as we follow the shore comes an amygdaloid breccia with a stratified sandrock cement like the ashbed. Then again jaspery brecciated rock. Then large belt of trap intermingled with the brecciated amygdaloid.

On the other side of a creek which comes out of a small lake (Or Lake) on the maps, a porphyritic dyke 4 feet wide is indicated on the maps. This is a true conglomerate belt embedded within the trap, but the nature of this conglomerate shows a relationship to the jaspery breccia previously exposed.

Near the promontory in the N.W. corner of Sec. 36, T. 58, R. 28 I struck off from the shore in N.W. direction, first through a bad cedar swamp, then ascending high land passing through Sec. 26 I found one ridge composed of a laminated red jaspery rock like some of the beds exposed on the shore. Further on constantly ascending and descending over precipitous trap hills we came in the north part of Sec. 23 into a large swamp.

In Sec. 14 we struck in the swamp on a lumber road leading north northeast and subsequently northeast which we followed until we came on a high trap ridge. Then expecting the road would soon turn we ascended the hill almost in east direction until it became evident to me it would lead constantly away from our homeward direction so I took another old abandoned road leading WNW through a ravine north of the high trap ridge. We found on the way some abandoned mining pits. Coming to the bottom of the ravine I turned off north across another trap ridge where also mining trenches were very extensively opened. This is in the N.E. $\frac{1}{4}$ of Sec. 14.

Saw the little lake inclosed between ^{Sleep} trap bluffs. From here ascended the greenstone bluffs in S.W. $\frac{1}{4}$ of Sec. 11 where a splendid view is opened towards the lake and over the Montreal river valley. I saw across the lake the Huron Mountains very plain, westward Mount Houghton presents itself as an isolated cone much rising above the other hills of the shore chain of mountains.

From the height of the greenstone bluffs I had a very tedious travel across 4 or 5 other rocky ridges until finally almost exhausted I struck the road again over which we had traveled the day before. We struck it about in the N.E. $\frac{1}{4}$ of Sec. 10 and after 3 miles further walk arrived at the Clark mine where we camped. I felt sick from over exercise and not having eaten anything from 6 o'clock in the morning to 6 in the evening. Slept on fresh hay in an old house.

Monday Aug. 13. Fine bright weather. Went over the burrows of Clark mine. Found plenty of copper bearing Frehnitic seams intersecting the coarsely crystalline trap rock. The trap varies from aphanitic to very coarse grained black, grey, reddish or greenish mottled. Some of it weathers very quickly, other pieces do not seem to be affected much by exposure to the weather.

Went to the shafts on the so-called east vein of Clark mine about $\frac{3}{4}$ of a mile north of Clark mine where another fissure vein apparently richer in copper than the other is worked. The wall rock is in the southern part of the adit. A dark trap then follows, northward an amygdaloidal belt which about 100 steps north of the mine is overlaid by a very large conglomerate belt. The vein is followed some 20 or 30 feet into the conglomerate but as it was poor in copper further drifting was omitted. This mine furnishes many beautiful specimens of calcspar, datolith, stilbite, analcim and part of the copper is disseminated in the vein matter in well formed crystals.

Afternoon went back to the Aetna location loaded with a heavy pack of rocks. I felt sick and towards night I had a severe chill, headache and nausea. Went early to bed hoping to feel better in the morning but I felt worse and decided therefore to return to Delaware. Sent man to Copper Harbor for a conveyance.

Tuesday Aug. 14. This morning I found ice $\frac{1}{4}$ of an inch thick on our water cup. Monday evening the foreman of the lumber camp passed by and on inquiry told us that his camp is 8 roads (rods) east of the town line, consequently we followed the town line, the other day and was not on Mount Houghton at all. The abrupt shape of the mountain which the hill we ascended did not exhibit made me then doubt whether I was not on the wrong line.

Sent for wagon to Copper Harbor which brought me to Delaware, 3 dollars. Mans wages 14 dollars.

Wednesday Aug. 15. Left with stage for Calumet and thence returned to Houghton.

Thursday 16. Was all day in bed taking ? and in the evening Dovers powder which gave me some rest,

Friday 17. Determined to go home. Packed up and am ready to start for Marquette.

Saturday Aug. 18. Traveled to Marquette. Arrived about 2 o'clock afternoon. Procured through ticket to Ann Arbor for \$20.55

At Marquette every hotel was overcrowded and first I feared to have a poor change for night quarters. But Mr. Swinford kindly offered me his house and I rested there the whole afternoon. In the evening I succeeded in obtaining a good room at the Tremont house. Mr. Osborn helped the state of my head(health) considerably by calling for a bottle of champagne and a tolerably good night rest. But after being about for awhile I at once got unconscious and fell down, which however did not last long.

Sunday Aug. 19. Went to Wagners who showed me porphyritic rock specimens collected by him in Town 49, R. 41, Sec. 6. Another truly porphyritic rock he collected in T. 49, R. 42, Sec. 12.

Notes from back of book. Jacob Bausch. Helltown

Mr. D. Beaser tells me the two ranges of the Porcupine dip north but the summit of the south range seems to be the acme of an anticlinal as on its south slope the beds dip south with gradually decreasing dip. Down in the valley the horizontal sandstones are found until further south the trap range of the Rockland district rises again with a northern dip.

On the summit of this anticlinal a red porphyry comes to the surface as the lowest of the series and outcrops of this porphyry can be traced from the Porcupines into the Black river drift, a distance of 30 miles. 4 miles east of Ontonagon are quarries in horizontal silurian sandstone on shore. Horizontal sandstone is also found in digging a well one mile and $\frac{1}{2}$ south of Ontonagon at the dwelling house of Mr.

Allouez. Foot of conglomerate, a grey semi-amygdaloid trap, large belt. Amygdaloid from 12 to 30 feet. Hanging a compact black trap like the base of the cliff bluffs. Then a large alternation of amygdaloid and trap belts, many showing a stratified structure (fluid). This alternation nearly $\frac{1}{2}$ mile wide. Further north is the situation of the stamp mill which is on the large amygdaloid belt of Eagle River.

Ryans mine at $\frac{1}{4}$ post between Sec. 20 and 21.

2 pages of German.

On map of Stephens and Hill there is the large conglomerate belt of Eagle River. Farther south on Gratiot river succeeded by another broad belt of melaphyr and that again overlaid by a broad conglomerate belt. This same succession is also indicated in the copper harbor district where the large conglomerate belt at the harbor is overlaid by a trap belt and that again by a conglomerate.

In Fumpelly's sections.

Kearsarge Conglomerate No.11

Northstar conglomerate No.12

Calumet " 13 - from Calumet to Kearsarge 1077 feet

Albany--&--Pester(Houghton Congl) No.14 Allouez to Houghton congl. about 400 feet.

Allouez Congl.(Albany & Boston) No.15 Allouez Congl.

Pewabic West Congl. No.16 - On Seneca property by measurement 1570 from supposed Calumet belt 2260 the horizontal distance

Hancock west congl.(South Fewabic) No.17 From Calumet Congl. to Osceola Amgd.528 ft horizontal 760.

Conglomerate 18 to 21. Exposed on south side property this side of Atlantic Stamp Mills.

Congl. No.14 exposed in creek on Dakotah property.

No. 1 conglomerate is considered the conglomerate in the ravine southeast of Mats vein.

No. 12 is said to be exposed somewhere near the Houghton Candle factory.

From Osceola amygdaloid to Kearsarge conglomerate 549 feet, horizontal distance 790 on Seneca property.

Trains leave Marquette westward A.M. 8:35, 11:40, P.M. 1:45, 6:10

Arrives Michigamme 10:30 Arrives LeAnse 5:15 Arrive Mich. 8:10

From LeAnse eastward A.M. 9:15 arrival at Marquette 12:30

From Michigamme eastward A.M. 10:40, and 6 A.M. P.M. 3:10

Sahlbach Lake LaBelle.

Trk Mayer, Hell Town.

William Smith, German, Delaware this side of location. Good man for the trip to Mt. Houghton.

H. Gibbon Copper Harbor.

Notes from front of notebook.

T. 56 R. 32, Sec. 7. N. half of Wolverine N E $\frac{1}{4}$ between Calumet and Wolverine
Kearsarge conglomerate 2300 ft west of Seneca (?) Calumet and Congl.

Peter Mitchell, Ontonagon. Spec. of Huron limestone to send.

Daniel Beaser, Ontonagon Copy of reports, to ask from Governor.

Superintendent James, Minnesota.

Superintendent W.J. Parnell

Other notes in German

C. Rominger May 1884

May 20, 1884. Left Ann Arbor with Toledo R R. \$17.00 to Marquette. Arrived at Marquette Wednesday 21, at six P.M. Paid 50 cts for baggage transportation, \$1.50 for meals.

Thursday 22. Rain all day. In the cuts of the D & M. R.R. through the rock bluffs all along from Whetstone Creek to the Cleveland dock the intimate association and transition of schistose and massive dioritic rocks is well observable. The massive diorite is most of fine grain appearing to be a homogeneous mass of light green colors often intersected by linear seams of calcareous feldspathic and epidotic composition. Another portion of the rock is coarser grained and with the simple loupe its composition of whitish plagioclas and grass green hornblende crystals can be recognized.

Often globular concretionary masses are segregated in the diorite which consist of the same material and probably originated from agitation of the yet semi-liquid plastic rock masses. The schistose beds inclose several narrow seams of blood red jasper and exhibit locally considerable corrugation by the uplift.

Friday May 23. Examined the rock series within the city of Marquette on east side of principal business street east of the schoolhouse. The strata have a trend from east to west, dip under a high angle to the north.

North of the large series of softer thinly laminated schists represented in the bluffs near Grace furnace and further upon the hill a very large series of well laminated compact dioritic schists with even cleavage and of somewhat rhomboidal fracture follows, which incloses a large augitic belt intersecting them nearly parallel with the trend of the formation. This same belt is also exposed on the lighthouse point.

North of this series amounting to over 500 feet a belt of banded ferruginous rock succeeds, then comes a coarsely crystalline diorite and a series of other entirely similar compact schists as the before mentioned. Further north within these schists a number of narrower and several quite large belts of granite are inclosed. The granite has a more or less distinct laminated structure.

Diagram

Saturday 24. Examined the same series as yesterday in the west part of the city going out on the street occupying the summit part of the hill. I collected a specimen of an eruptive diorite belt intersecting the large novaculite-schist belt nearly parallel with its strike about 200 steps north (on Arch St.?). The compact well laminated beds of dioritic schist are well exposed. A branching augitic dyke intersects them. 200 steps further north the same laminated compact dioritic beds continue. They inclose seams of laminated granite parallel to their strike but branching sideways across the beds.

Going from here east and a little north the laminated diorite continues to be exposed. Portions of it are more massive and not so plainly laminated. Also coarsely crystalline masses are locally found in the rock belt which are not demarcated by a definite line from the fine grained laminated portions. Also here a branching augitic dyke intersects them. The total thickness of the laminated sub-schistose diorite series amounts to over 1200 feet.

3 Sunday May 25. Followed from the brownstone quarries the new road built to Ne-gaunee. It follows from the poorhouse a southern course and intersects the Mt. Mesnard quartz ridge at the gap which separates the chain. On the entire space only in one place quartzite bluffs steeply erected with southern dip are exposed on the east side of the road. The road itself only cuts through drift sand accumulations. After intersection of the quartz chain it turns west following Carp River on the lower third of the hill slope. After going about 3 miles on the road I returned. In the afternoon went to Lighthouse point. The granite dykes there are abruptly truncated, have a laminated structure.

Diagram

West of the Picnic Islands on a road leading up to the north part of town dioritic outcrops occur which correspond with the rock of the Picnik Islands. Part is a fine grained compact diorite, another part is coarsely crystalline like the rock on the island and portions of that consist exclusively of large dark green hornblende crystals some two inches long. In scattered dots plagioclas is interspersed which often is partially replaced by epidote. Also pyrites is abundantly disseminated. After ascending the bluffs the large granite belt spoken of yesterday is intersected by this road on both sides of which the dioritic schists are coarsely crystalline and contain instead of plagioclas red orthoclase.

Monday May 26. Went to Ishpeming with morning train

6 pages of German

Thursday May 29. Packed specimens. Left them at Clifton hotel

The hematite mines south of village are all suspended. Collected good specimens of pyrolusite. 1 specimen of diorite cropping out in the hematite mines. Then went to the diorite hills north of village. Two specimens from there. A diamond drill is at work 1 mile east of the village. Not far from the shaft sunk in former years by Lonsdorf and Mass. Another drill hole is commenced in the middle of the village. They are not on the ledge yet. Returned to Marquette.

Saturday May 31. Fine warm weather. To Saginaw Station 75 cts. Went to the hills across Escanaba and met on lower part of slope compact banded quartz schists dipping under high angle north. Above them is the massive brecciated rock often described before as resembling a dioritic rock. This belt is several hundred feet wide and forms the first range of hills behind which a second quartzite and slate rock beds of the arenaceous slate group form their body. Going west this quartzite associated with blackish slaterock forms the hills on the line between Sec. 12 and 13 of T. 47, R. 28. Their dip is north. The quartzite beds are locally brecciated.

2 pages of German

Monday June 2. To Champion mine. R.R fare \$1.20. Return \$1.20. Diallage rock on footwall of ore, partly light, whitish colored, partly dark chloritic and impregnated with ore granules. About in the same horizon garnetiferous chlorite schist occur with diallage associated and sometimes with nests of black Tourmalin, also white silvery hydromica schists form layers.

Some are mixed with hexagonal tabular crystals of brownish red color whose nature I have to examine under the microscope. The position of these beds is under the first belt of ore which is overlaid by the so-called soapstone and then by the large quartzite belt. North of the quartzite is a large series of slaty rocks interlaminated with quartz seams which strata are well exposed. On the road from the depot to the lake among the slates are some black graphitic, others grey, others hematitic colored, and some resemble the dark ferrugineo-pyritic slates of the Commonwealth. All dip north.

The actinolite schists at the Champion Furnace appear to be still higher layers in the succession. Of the conglomerates and breccias north of the Keystone mine, at the Champion no outcrops can be seen. South of the garnetiferous and diallage bearing beds other narrower ore seams occur. The diorites further south are lenticular intrusive masses which probably are altered sedimentary rocks.

Tuesday June 3. Paid Hotel bill, 13 days, \$26.00 Bought 50 cigars \$3.00. 1 o'clock left for Houghton. R.R. fare with baggage transfer \$5.00.

Passing over the granite range west of Michigamme I observed a laminated structure of nearly all the exposed granites, often also a brecciated condition by intermixture of dioritic rock fragments with the granite mass, large bodies of this brecciated rock occur. Near the Summit Station on the western slope the laminar composition of the granites is best seen. Not far west of there other laminated beds come to the surface which seem to be metamorphosed strata of the slaterock series which in the neighborhood covers the surface all the way down to the bay.

Arrive in Houghton 6 o'clock. Found there Mr. Ames and Miss. Conover which send their respects to the children.

Wednesday June 4. From bridge large belt of diabase in massive compact beds, then a breccia of amygdaloid epidote rock and a brown fine grained silicious rock about 40 feet wide. Then massive diabase again. At the creek near Mr. Raymonds house the flood has laid open a broad belt of a brown earthy amygdaloid of brecciated structure full of seams of laumonite, width of belt about 30 feet.

Another entirely similar amygdaloid belt succeeds above, separated from the other by a compact diabase belt about 40 feet wide. In this amygdaloid big lumps of epidote rock are inclosed. Going up the stream constant exposures of the brecciated laumonitic and epidotic amygdaloid irregularly alternating and intermingling with massive diabase can be observed.

The amygdaloidal and compact trappean rocks are not at all found in defined seams but intermingle. The amygdaloidal portions appear to have been loose fragmental masses of the diabase which suffered more from decomposing influences and finally were cemented by infiltration of calcspar laumonite and some quartz of the sandstone belt. Indicated on Pumpelly's map in this locality, I could see nothing although the ledges are perfectly denuded in the entire length of the creek bed.

Thursday June 5. Capt. Brandt, Belt mine. Capt. Dunn. Albany and Boston. Went over the burrows of Isle Royal mine next south of the Portage and found good specimens of analcim ectr. Afternoon I did not go out as it was very hot and nothing in the neighborhood which I had not seen before.

Among the minerals of the Isle Royal is one which forms small regular hexagonal columns with a straight terminal plain to which a micaceous cleavage is decomposed and hollow or porous in the centre while non-transparent and soft. Compare apatite and hydrargillite.

Friday June 6. Visited Douglas Convord and Acadia mine, all of which are in a belt supposed to be identical with the Isle Royale belt. It is a brown chocolate colored dull earthy looking amygdaloid with abundant epidotic masses intermingled in a brecciated manner, spar and quartz and red feldspar seam intersect the rock, copper is not often found in the rock masses of the burrows.

From the mines I went over by a good road to the Quincy. Afternoon went to the Isle Royal mine again and collected specimens of what I consider to be stilbite.

Saturday June 7. Waited for the departure of the Tremont which has its regular time at half past ten but did not get off until late in the evening. Paid \$10.00 hotel bill for 4 days. N.B. Left a box of specimens at the hotel. Steamboat fare \$5.00. Arrived at Ontonagon at 12 o'clock at night.

Sunday June 8. Rainy, cold day. Could not go out. Quite a large quantity of mass copper on the dock, all of it surrounded by bright green epidote which is in contrast with the masses of the Keweenaw district which are imbedded in white calcspar.

Saw Mr Peter Mitchell which has quit the exploration in T. 46, R. 42 as no better quality of ore could be found there. The railroad is now advanced to a distance of 3 miles south of his exploring pits. At the south end of Gogebic Lake a hotel has been built and from it a road $6\frac{1}{2}$ miles long is cut to the next station of the railroad which shortly will reach to Sunday Lake.

Monday June 9. 1 woollen, 1 linen shirt, 1 robe, 2 socks gave to laundry.

Explorations for gold in T. 47 R. 43, Sec. 28. Gold in a quartz vein carrying iron pyrites about 16 inches. Also explorations for gold in Sec. 10, T. 47, R. 45. Iron ore in Sec. 21, T. 47, R. 43 by Tobin and Swain.

Tuesday June 10. To rockland. \$1.00 return ticket. In the old western pits of National mine all the work is done right below the massive diabase belt. The conglomerate forms the footwall of the pits. On the conglomerate and adhering to it is a seam of dark rotten amygdaloid about 1 foot wide, its upper face contiguous with the massive diabase is slickensided polished. The thickness of the conglomerate is as far as I can see from 20 to 25 feet wide.

After inspection of the National and Minnesota I have noticed (noted) the following: the strata dip north under an angle of about 50 degrees, the conglomerate is generally about 20 or 25 feet thick, its upper face is either slickenfaced or as before said a seam of rotten amygdaloid covers it on which then a massive diabase from 75 to 100 feet follows. Then comes the so-called north vein, a cupriferous amygdaloid belt about 4 to 6 feet wide. Above it is again massive diabase. This amygdaloid seam can be traced for a long distance by natural outcrops and by pits sunk on it.

The copper bearing horizon of the south vein is above the conglomerate and not below it as stated in the report of mining statistics but large masses of copper are usually extending into the conglomerate footwall of the mine.

The south vein next to the conglomerate is very rich in calcspar seams and forms a breccia of amygdaloid and epidotic fragments cemented by spar and by leuconite seams.

In the National mine a fissure vein intersects the conglomerate belt which is very productive in copper. It is about 1 foot in width. Outside of the conglomerate this fissure is not near as rich. The sparry rock on the burrows comes from this fissure.

After dinner went to the porphyry outcrop north of Rockland. It forms a massive belt about 100 feet wide as far as visible. The hanging and footwall of it is not seen. It is a true porphyry with many quartz grains interspersed. No signs of stratification.

Wednesday June 11. To Mass mine. \$1.00 and return. Minnesota conglomerate about 2500 to 2600 feet north of Knowlton vein. Went through the tunnel in company of Mr. Brandt and Mr. Edgar Rathbone. Saw the different copper bearing belts all dislocated by a fault on the line of the tunnel. In all four belts longer or shorter side drifts are opened and everyone of the belts is sufficiently productive of copper to be mined.

The Knowlton mine contains much of the red rhombical mineral which I supposed to be feldspar, in association with calcspar, copper and epidote. The appearance of the mine is quite favorable as to the amount of copper contained in the different belts. The dip of the strata is about 55 degrees. The ore bearing belt is not always clearly defined from the walls and an undulating or zigzag course is observable. Promised Mr. Brandt to come to the Belt mine on Friday with the understanding to give him notice by telephone Thursday evening.

Saw in Mr. Chenoweths collection specimens of heavy spar from the National mine. At Rockland \$2.00, 1 days hotel bill. Bought 5 rock specimens \$5.00.

Thursday June 12. Cold, rainy. Temp. 42°.

Friday June 13. Rain. Temp. 58° at noon. Bought provisions for \$10.00

Saturday 14. Went to Belt mine, stage there and return \$3.00. At the Belt mine the mining in the so-called Battler or Champion vein is not giving good results. They find the great bulk of the vein matter not sufficiently rich for indiscriminate use as a stamp rock. Still there is some mass and barrell copper in the vein. Near the west boundary of the location close to Agent Brandt's house the Ogema belt is opened by an old shaft which is not worked now.

The most promising work on the location is done in the Knowlton vein at the north side of the bluffs. The vein is 20 or 30 feet wide but only 7 or 8 feet of it are stooped out as the richest part. The depth of the beds is about 43 to 45 feet. To the north the shaft is now somewhat over 200 feet down. A test made in the stamp mill by a week's run gave a result for this vein rock of about $3\frac{3}{4}$ % of copper inclusive of the mass and barrell copper found with it.

The mill is a very superior structure with excellent machinery for the present. One ball pump is in operation and the material for putting up another one is on the ground. The ball stamp is 18 inches diameter, capable of pounding about 200 tons of rock a day.

Sunday June 15. Prepared for a start tomorrow.

Monday . Went with stage to None Such . 4 persons \$6.00. Paid hotel bill 9 days \$18.00. Handed to hotel keeper \$150.00 for safe keeping. Arrived at the mine 3 o'clock.

None Such strata dip S.E. under an angle of about 35 degrees. The mine is in the S.E. $\frac{1}{4}$ of Sec. 1, T. 50, R. 43. The high bluffs a mile north of the mine are in T. 51, R. 42. Our direction for tomorrow's trip is S.W. to the S.E. corner of Sec. 13 in T. 50, R. 44, then on section line north to the S.E. corner of Sec. 12.

Tuesday June 17. Some rain during the night and early in the morning but clearing up after 6. The series at the None Such above the copper bearing seam is exposed in the creek in a thickness of about 300 feet. Most greyish blue argillaceous-arenaceous beds, some harder, others softer, quite even bedded, approaching to slaty.

Above the ore bed are fine grained blackish argillites which contain frequently sheets of copper. Beneath the ore seam the strata are more a sandrock locally crowded with porphyry pebbles of the peculiar cellulose structure if seen under the microscope. The beds beneath the ore belt also are visible to the amount of about 300 feet. The lowest beds are prevailingly conglomeratic.

Arrived at Mr. Beasers camp in sec. 13, T. 50, R. 44, 350 steps south of N.E. corner. 330 steps north of that corner in a creek and in a testpit the cupriferous beds of the None Such mine are exposed. They strike N.E. and S.W., dip S.E. under a high angle of 75 to 80 degrees. In the same creek lower and higher beds of this series are exposed. North on the section line near the N.E. corner of Sec. 12 a high bluff consists of an altered quartzose feldspathic rock similar to the jaspery beds I observed last year on the hills further west 2 miles.

Wednesday June 18. Left camp at 7. Followed section line north. At the $\frac{1}{4}$ post the land begins to rise more briskly. Further on red jaspery beds apparently of sedimentary origin dip under a high angle southward in conformity with the None Such formation below the hill. Higher up, reddish grey, more massive silicio-feldspathic rocks form the top of the hill. The section corner is on the edge of the summit on such rock beds. From here we descend into a deep ravine and ascend again a higher hill range than this by following the section line further north. It took about 1 hour for traveling one mile.

About $\frac{1}{4}$ of a mile short distance west of the line a large exposure of red jaspery rocks is found. The rock is massive, full of joints, breaks into very irregular angular fragments. Further on we ascended going north various high hills, all of which exhibited outcrops of the same jaspery rock, sometimes light grey colored, other times reddish brown or also brick red. The masses show no stratified structure and nothing is to be made out regarding their dip. We lost the section line and did not notice when we crossed the northern town line.

We ascended the high hills in the east half of Sec. 34, T. 51, R. 43 which all consist of the same massive jaspery rock not distinguishable from the belt further south but found no section line to establish our exact whereabouts. From the top of these hills a good view southwards is to be had and north the next range seems to be the hills on which the Carp Lake Survey Station is erected. We returned to camp by going according to the compass south. Crossed many large outcrops of the jaspery rocks and arrived at camp at 4 o'clock in the afternoon very much tired. See the various specimens collected. No. 3, 4 and 5 are from Sec. 34.

Thursday June 19. To S.W. corner of Sec. 12, thence north 325 steps outcrop of porphyritic rock, see specimen. Thence to N.W. corner of Sec. 12, there on both sides bluffs of porphyry, a creek running between them running north. See specimen. Thence north to bluffs in S.W. $\frac{1}{4}$ of Sec. 1. Thence back to corner, thence west porphyry massive, no dip to be made out. The hill in Sec. 1 only about 300 steps north of the S.W. corner of the section is very high, gives a splendid view in S.W. direction, rock the same porphyritic nature as at the corner in high walls facing west and northwest.

From there we return to the N.W. corner of Sec. 12 and follow the line west over various high hills of red porphyry. The N.W. corner of Sec. 11 is on a very high porphyry hill, the porphyry fine grained, homogeneous, red colored.

Further on at the 16 post a large creek from here about 700 steps is a high hill of diabase separated by a swampy valley from the porphyritic hills. From the top of diabase hill fine view on Lake Superior.

Friday June 20. Returned to None Such. Sent men the old trail with the packs and went ourselves back over the southern ridges of the Porcupine mountains, our line of travel is indicated on the map. On north line of Sec. 7 between the 2 arms of Little Iron River red Felsites compose the body of the hills. The surface is however frequently covered with boulder drift. At the eastern arm of the creek dark trappean rocks crop out in one place occupying the south side of the red jaspery felsites.

From the creek took N.E. course constantly ascending until we reached the high plateau of the ridge which totally consists of massive red felsites locally exposed in high vertical walls. Particularly I mention the bluffs in a creek in N.E. $\frac{1}{4}$ of S.W. $\frac{1}{4}$ of Sec. 4, T. 50, R. 43. Further east and lower down the hill slope are large exposures of amygdaloid diabasic rocks joining the red felsites on the south side. The top part of the hills consists of the felsitic rocks. In the hills further east in Sec. 3 I observed last year the same occurrence of amygdaloidal trap on the south side of the felsitic rocks forming the top part on east line of Sec. 4. We descended to the lower levels and saw no more outcrops. The travel was very good unto the S.W. corner of Sec. 2 but from there following the section line the traveling is horrible, and no outcrops of rock visible.

Saturday 21. Went to high hill N.W. of None Such location. Struck first the west $\frac{1}{4}$ post between Sec. 1 and 2. The higher portion of the slope shows many exposures of a dark purplish colored felsitic rock holding the middle between the red jaspery or porphyritic beds and an amygdaloidal trap. Large outcrops of the same kind are on the east side of the hill slope which in one place have a dip to the northeast. The summit of the hill is plateau-like and shows no exposures. This dark pseudo-trappean rock is essentially the same as found yesterday on the south side of the red jaspery belts.

Afternoon went by road to the fifth creek intersecting the road to Union mine 2675 steps from the location and found in that fine exposures of an amygdaloidal rock of reddish brown color. The rock lies almost horizontal with only a slight northern dip. See specimens. In the other creeks no outcrops could be seen. Specified distance from our camp to intersection of the road by the centreline something over 500 steps. From there to a small shallow creek, 680 steps. Thence to second creek 420 steps. To third, 100, to fourth 175, to fifth 800 with the outcrops of amygdaloid almost horizontal.

The None Such formation continues eastward to the White Pine location 6 miles distant from the None Such in Sec. 5 of the T. 50, R. 42. It is also traceable across the Ontonagon river and openings near Maple Grove show the same rock. Westward it is traceable to Black River and comes up to the Lake Shore near Maple River 3 miles west of the Black River, dips there north.

Sunday June 22. Followed Little Iron River downward. After leaving the location no more outcrops are seen for about 3 miles. Then a belt of sandstone crosses the river from east to west and dipping north under an angle of 50 degrees or more. This belt is for 100 steps exposed then without an interruption of the outcrops the beds at once strike from N.E. to S.W. and dip S.E. under an angle not over 25 degrees.

The rock in both exposures apparently is the same, a brown fine grained sandstone. This dip and strike continues for 200 steps then at once again the beds dip under a high angle north and strike east and west but the exposure is only small. Then for 145 steps no outcrop. Then a big turn is made by the creek into an eastern direction. After a little the river flows north again and the brown sandstones are largely exposed, strike N.E. and S.W. Dip S.E. under an angle of about 30°, very wide, between 400 or 500 feet, some conglomerate seams in it. The lowest beds resemble the copper bearing strata of the None Such. Then abruptly a change in the beds is visible, the strata at once strike east and west and dip north.

Diagram

The beds with northern dip are bluish arenaceous beds with even bedding. The dip is first very steep. A piece onward it becomes much flatter and soon after beds are exposed in the bed of the creek striking northeast and southwest and dipping southeast under low angle, almost horizontal. Here are falls 4 feet high (N.E. $\frac{1}{4}$ of Sec. 24).

Some distance below the strata dip under an angle of about 15 to 20 degrees east strike north and south, blue slaty layers. This place is on N.W. $\frac{1}{4}$ of Sec. 24 close to line on Sec. 13. For long distance downward the exposures of the blue slaty beds continue regularly with the same dip and strike. They amount to many hundred feet.

At the Scranton mine the strike of the strata has become gradually changed into N.E. and S.W. trend and into a S.E. dip of quite a low angle. Lower down above the bridge on lake shore the position of the bed is opposite. Strike S.W. to N.E., dip N.W. under low angle, red sandrock below the blue beds. Returned to None Such at 4 o'clock.

Monday June 23. Went south on the Lake Gogebic trail. Left at 8. The trail runs almost due south, is a railroad survey line, goes through the eastern tier of sections in Town - range 43. No outcrops are seen on the trail but crossing Big Iron River the rock fragments filling its bed **indicate** the occurrence of the None Such formation there.

In T. 49, R. 43 I left the trail to go $\frac{1}{4}$ mile west from it to a high hill with large outcrops of a dark compact rock, rather massive than stratified. The dip is N.W. See specimens marked $\frac{1}{4}$ post on south line of Sec. 1, T. 49, R. 43.

Returned to trail and followed it a mile. Then turned on section line between 12 and 13 east to the east corner between the two sections where in the creek a branch of iron river, dark trappean rocks are exposed. Part of them is amygdaloid part compact. The creek runs through a ravine with steep sides, dip N W.

Tuesday June 24. Followed section line eastward. Found on line between Sec. 8 and 17, 1/8 mile from east corner a large hill composed of quartzose porphyry massive without any sign of stratification. From there the line follows the south slope of a range of porphyry hills with frequent large outcrops unto a creek running through the centre of the south line of S.W $\frac{1}{4}$ of Sec. 10, T. 49, R. 42, where we took dinner.

From here along the line of Sec. 10 and 11 the porphyry hills continue presenting precipitous high bluffs particularly on Cascade River valley which the porphyry does not cross, in S.E. $\frac{1}{4}$ of Sec. 11 it bends northeastward across Sec. 12 facing Cascade River with very high bluffs.

We crossed the Cascade, went to corner, followed south line of Sec. 12 which is low land gradually ascending. The slope of the trap range on that side is very gentle and without mounting any steeper hill we arrived going east near the mouth of Cascade River on Lake Gogebic road and camped there. Night very cold.

Wednesday June 25. Returned to Ontonagon. Hired wagon for \$10.00. Arrived 3 o'clock in the afternoon. Paid men for 10 days labor \$40.00. \$1.00 to Harry Raus for packages brought from the None Such mine. Received letter from home. 1 package with specimen No. 1, specimen No. 2 was lost, from a party in Millbrook Michigan. Specimen No. 1 is a weathered globular pebble of disbase.

Thursday 26. Packed a box with specimens. Delivered it to Mr. Mercer. Wrote letter to Governor and home.

Friday 27. Fine clear weather. Wait for good wind to go with Mr. Parker to Isle Royal. Engaged Jacobi to go with me.

Saturday June 28. Ready to sail, a fair south wind. For provisions \$8.00. Hotel bill \$6.00. Left with hotel keeper \$90.00 for safe keeping.

Sunday June 29. Arrived at Grace Bay 6 o'clock in the morning. Parker failed to bring us to the head of Washington Bay as he agreed to do. The locality where we landed is altogether unfavorable for explorations, all dense forest with low swamp land. The point to the west shows some outcrops of trap. Dip S E. The trap contains reddish masses of amygdaloidal rock and seams of a reddish crystalline rock.

Monday June 30. Tried to go to the conglomerate hills S.E. of us but found the woods impenetrable by windfalls and returned. Built a raft and passed time catching trout which abound in the creek near camp.

Tuesday July 1. followed the shore to entrance of Washington Bay. Outcrops of trap in many places, dip apparently to the south. Trap most compact, much mingled with Rubellan (rubellite). Amygdaloid masses locally mingled with the compact trap amygdules, calcspar, laumonite, prehnite and quartz. Not cupriferous portions of the massive trap are brownish red colored. Much of the trap has the birdseye structure and its superficial parts are decayed, crumbly.

At noon Mr. Parker arrived and we went on board.

Wednesday July 2. Sailed at 7 from Grace Harbor. Had a contrary wind and arrived Thursday morning at 7 in Siscowit harbor. The shore line we passed exhibited on most westerly point of the island outcrops of a conglomerate belt, otherwise no rocks were seen. All the island is densely covered with forest.

On entering Siscowit harbor the ridge forming the south side of the large harbor consists of a hard brown well stratified sandrock dipping under a low angle to the south. The opposite shore where we landed is formed of conglomerate rock dipping under an angle of about 25 degrees south. This belt is very wide, 1000 or more feet. The pebbles are various kinds of red porphyry and porphyritic amygdaloid rock with very large whitish or reddish feldspar crystals besides amygdules filled with spar, delassite, quartz ectr., also numerous agate nodules are inclosed in the conglomerate.

The Island mine is about 3 miles north of the landing. A good road leads to it, first crossing the large conglomerate belt, then a broad space covered with drift intervenes. At the location, first various compact and amygdaloidal trap beds dipping under an angle of about 30 degrees to the south form the first range of hills. Under it a conglomerate bed about 18 feet wide succeeds of which 2 feet are cupriferosus and have been mined but evidently not with the desired success. The footwall of this conglomerate is an amygdaloid. Then follows compact trap and further north still other trap belts are seen exposed which form the hight of the hill range over 300 feet high.

Further I did not examine. The amygdaloid above the conglomerate contains large concretionary masses of prehnite, Tomponite and quartz mingled. Also calcspar enters into the composition of these concretions but they do not carry any copper. All day contrary wind but clear sunny weather.

Friday July 4. Returned to Ontonagon with fair wind. Left entrance of Siscowit Bay at 6 in the morning and arrived at Ontonagon at 10 o'clock in the evening. Paid man for 7 days wages \$14.00. To Mr. Parker for boat \$30.00.

Saturday July 5 The past night a thunderstorm with rain and heavy west wind came. This morning a cold strong wind blows and the lake is very rough so that had we not returned our situation on the lake today would have been a dangerous one. Received letter from home and one of Cousin John Rominger.

Sunday July 6. Fine weather but cold. Thermometer at 10 o'clock only 48 degrees. Wrote letter home.

Monday July 7. Fine weather but cold. Expect to return tonight with steamer Fremont to Houghton. Delivered a box of specimens to Mr. Mercer.

Tuesday July 8. Arrived with steamer Fremont at Houghton 8 o'clock. Paid \$5.00 fare.

Wednesday July 9. Examined the brecciated amygdaloid belt west of the bridge. Its width 30 feet, its composition a brown amygdaloid serving as ground mass for copiously imbedded angular fragments of an epidote rock and of a liver brown amorphous rock mass which exhibits traces of stratified or else laminated structure.

The foot and hanging of this belt is a compact grey crystalline trap rock which likewise incloses chinks of epidote rock merging with the trap mass. The belt in the hanging is very large, continues past the candle factory. The belt in the foot-wall likewise large continues to the bridge.

Thursday July 10. Went to Oseola and Tamarack shaft. Railroad fare \$1.50 . The Tamarack shaft is at present 1550 feet deep. The lowest stratum is a compact diabase (see specimens). Otherwise the strata at the depth of 1341 to 1357 are amygdaloid, from there to 1409 trap. From there to 1424 amygdaloid, 1424 to 1495 trap. 1495 to 1510 amygdaloid. From there to 1550 trap. See specimens.

Then Mr. Daniels went with me underground in an old shaft sunk on the Calumet conglomerate belt to the first and second level. The conglomerate is on the north side overlaid by a compact trap belt which incloses irregular masses of a copper bearing amygdaloid which is mined and forms a valuable addition to the product of the mine. The copper occurs most in coarser masses (barell work). See specimens collected there. Returned in the evening to Houghton. Received letter from home and papers from Governor to be signed.

Friday July 11. Sent vouchers to Governor and wrote home. Sent laundry.

Saturday July 12. Re-examined the strata west of Houghton bridge. The brecciated amygdaloid next to the large trap belt at the bridge incloses the fragments of epidote rock in such manner as to make it certain that they had the epidotic character already at the time of their inclosure and not by a subsequent process of alteration. In some of the epidote pieces the surface is smoothened and slickenside form. In the trap forming the hanging of the breccia epidotic masses are likewise abundantly inclosed which evidently had their epidotic character at the time of their inclosure.

Further on about 200 steps past Gottstein (candle factory) a brown crumbly amygdaloid belt of considerable width occurs which contains large amygdaloidal concretions of amorphous datolith and of laumonite, also chunks of epidote are locally intermingled. Then massive trap follows for about 500 feet or more. Next a brecciated amygdaloid belt very similar to the first one occurs. Close to it are old test pits on the road side. (see specimen).

In the creek coming down from Huron Stamp (Mills) a brecciated amygdaloid partly of brown color with spar and laumonite amygdules, partly of epidotic nature is inclosed between massive trap rock of locally pseudo-amygdaloidal character. The strata in places are so irregularly intermingled that the amygdaloid and the trap are alternating in patches and of neither the limits as a belt can be indicated. The amygdaloid is not cupriferous to any degree worth consideration. In one place the stratification of the amygdaloid is very regular, dip west northwest under a high angle. The stratified sedimentary nature of the deposit is clearly indicated by seams of well laminated sandrock making part of the amygdaloid belt. See specimen.

After examining the above described outcrop in the creek coming from the Huron Stamps I am clearly perceiving the subaqueous formation of the amygdaloid belt in such manner that the amygdaloidal trap over flow became partly shattered into angular fragments partly transformed into irregular rounded lumps which were surrounded and imbedded within sedimentary seams originating from the more comminuted particles of the trappean masses.