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THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

THE SIXTH ANNUAL REPORT

FOR THE YEAR 1877.

OFFICERS OF THE SURVEY:

N. H. WINCHELL, State Geologist,	In Charge.
S. F. PECKHAM,	Chemistry.
M. D. RHAME,	Topography.
P. L. HATCH,	Ornithology.
ALLEN WHITMAN,	Entomology.
CLARENCE L. HERRICK,	Laboratory Assistant.

Submitted to the President of the University, May 25, 1878.

MINNEAPOLIS:
JOHNSON, SMITH & HARRISON.
1878.

THE BOARD OF REGENTS OF THE UNIVERSITY.

ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN.,
December 31, 1877.

To the President of the University :

DEAR SIR—I have the honor to offer, and to transmit through you to the Board of Regents of the State University, the Annual Report required by law on the progress of Geological and Natural History Survey of the State, being the sixth since the beginning of the survey.

Very respectfully, your obedient servant,

N. H. WINCHELL.

STATE PUBLICATIONS RELATING TO THE GEOLOGY OF MINNESOTA.

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1. *Sketch of the Lead Region, by Dr. D. F. Weinland, with a statement of the objects of a geological and natural history survey. 34 pp., 1860. Reprint from the Wisconsin Reports for 1858. Out of print.*
2. *Statistics and History of the Production of Iron, by A. S. Hewitt. 47 pp., 1860. Reprint of a paper read before the American Geographical and Statistical Society, January 31, 1856. Out of print.*
3. *Report of Anderson and Clark, Commissioners on the Geology of the State, January 25, 1861. 8vo. 26 pp. Out of print.*
4. *Report of Hanchett and Clark, November, 1864. 8vo. 82 pp. Out of print.*
5. *Report of H. H. Eames, on the Metalliferous Region bordering on Lake Superior. 1866. 8vo. 23 pp.*
6. *Report of H. H. Eames on some of the northern and middle counties of Minnesota. 1866. 8vo. 58 pp. Out of print.*
7. *Report of Col. Charles Whittlesey on the Mineral Regions of Minnesota. 1866. 8vo. 52 pp., close type, with wood cuts.*
8. *Report of N. C. D. Taylor on the Copper District of Kettle River, incoporating Mr. James Hall's estimate of the copper prospects of that district. 1866. 2 pp. 8vo. Found only in the Executive Documents.*
9. *Report of a Geological Survey of the vicinity of Belle Plaine, Scott county, Minnesota. A. Winchell. June 17, 1871. 8vo. 16 pp.*
10. *The First Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1872. By N. H. Winchell. 8vo. 112 pp., with a colored geological map of the State. Published in the Regents' Report for 1872. Out of print.*
11. *The Second Annual Report on the Geological and Natural History Survey of the State, for the year 1873. By N. H. Winchell and S. F. Peckham. Regents' Report; 148 pp. 8vo.; with illustrations.*
12. *The Third Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1874. By N. H. Winchell. 41 pp. 8vo., with two county maps. Published in the Regents' Report for 1874.*
13. *The Fourth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1875. By N. H. Winchell, assisted by M. W. Harrington. 162 pp. 8vo.; with four county maps and a number of other illustrations. Also published in the Regents' Report for 1875.*
14. *The Fifth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1876. By N. H. Winchell; with Reports on Chemistry by S. F. Peckham, Ornithology by P. L. Hatch, Entomology by Allen Whitman, and on Fungi by A. E. Johnson; 8vo. 248 pp.; four colored maps and several other illustrations. Also published in the Regents' Report for 1876.*

[NOTE.—Of the foregoing, Nos. 1, 2, 4 and 6 are wanted by the Survey.]

REPORT.

I.

SUMMARY STATEMENT.

The Regents having authorized a joint examination with the State Board of Health of the water supply for domestic uses in the Red River valley, the first work undertaken in the season of 1877 was an attempt to ascertain the cause or causes of the unwholesome water often found in common wells throughout the valley of that river. About four weeks were spent in that part of the State, the observations extending from Breckenridge, the present terminus of the St. Paul & Pacific Railroad, to Winnipeg in Manitoba. The details and the results of this examination will be found in the following pages. It is sufficient here to say that the chief cause of the "stagnant," or foul water so common in wells of that part of the state was found to be the almost universal practice of curbing wells with pine wood; and that there is nothing in the water itself which is unwholesome or injurious. It is true that wells from the drift-clay are apt to be more or less alkaline, unless from extensive gravel or sand beds within the clay, but there is no reason, except artificial or unnatural causes, why the water of that part of the State should become foul or "stagnant" in common wells, any sooner or more frequently than in any other equally clayey portion of the northwest. It was found, indeed, later in the season, that this difficulty is by no means confined to the valley of the Red River of the North. It is encountered with equal frequency throughout the entire western half of the State, from the Iowa line northward to Manitoba, and must be referred to some cause that is not local in its application. In the absence of stone for walling their wells, the early settlers of the prairies, who have been generally men of little pecuniary means, have resorted to the use of pine plank for curbing them, on account of its availability and cheapness, and to this practice may be attributed by far the greater portion of the difficulty, resulting in many cases of sickness (usually typhoid fever) and many deaths. This fact cannot be too widely published, nor its pernicious effects on the general health and prosperity of the newly settled counties too strongly impressed on the people.

Reconnoissances into different parts of the state have been made during the season, having different objects in view, viz.: one into Wright county for the examination of localities of reputed "coal" outcrop ; one into Rice county preparatory to the survey of the county by Prof. L. B. Sperry; one into Goodhue county preparatory to the full examination of that county during the coming season ; one over the line of the Northern Pacific railroad supplementary to the water-examinations of the Red River valley earlier in the season, and for geological observations, and one into Morrison county for the purpose of preliminary geological observations. The results of these reconnoissances are given in the following report, so far as they can be made useful at the present stage of the survey.

In the survey of Hennepin county it was found necessary to embrace some parts of Ramsey, and during the past season the survey of that county was completed, and is herewith reported, with the usual maps and diagrams.

Rock and Pipestone counties, the most southwesterly in the State, have also been examined, and are reported in the same manner.

Rice county has also been surveyed in detail by Prof. L. B. Sperry of Northfield College, and his report on the same is herewith transmitted.

Further examination of the fossils of the Trenton was carried on during the intervals of interruption of the field-work, and some further notes on the same are given in the following pages. It cannot be expected, however, that while the field-work is steadily carried on the detailed laboratory work of palaeontology and lithology will progress with equal pace without the employment of extra assistance. Still such progress as is possible will be reported from time to time.

There is, accompanying this, a detailed report on the General Museum for the year 1877, showing the addition of minerals, and specimens of foreign rocks, as well as the naming of fossils in the cases of the Museum. There is work enough now on hand, in the Museum, to require the steady work of a man a whole year, with nothing else to do. It cannot be impressed to strongly on the Regents that there is a necessity of employing more assistance, or of the curtailment of some of the labor now devolving on a single man. It is certainly very necessary that the Museum be placed in its best condition. This implies the working up of many boxes of material, both in mineralogy and lithology, and in palaeontology. This is nearly all within the purview of the geological survey of the State, the material being almost all the product of the field examinations, and would redound to its substantial progress perhaps to a greater extent than the continued and constant prosecution of the field-work.

The report of Prof. Peckham on the chemical analyses of various substances submitted in the progress of the field-work is also included in the following pages; also, that of Dr. P. L. Hatch on the investigations he has prosecuted during the year on the ornithology of the State.

The year has been signalized by the disappearance from the State, and from the entire Northwest, of the Rocky Mountain Locust. The interesting and important report of Mr. Whitman on the phenomena and causes of such disappearance, and on other insects injurious to farm products still existing within the borders of Minnesota, is also transmitted herewith.

In Botany, while there has been a steady increase of specimens, gathered by Mr. Herrick, or presented by other collectors, there has been no attempt at classification or thorough examination. The progress of the work in this field will be mainly in the gathering of material, for several years; but finally the aid of expert botanists will have to be obtained in the preparation of a final report.

The officers of the Northern Pacific and of the St. Paul & Duluth Railroads very courteously furnished the State Geologist with passes over their roads while engaged in the northern part of the State, and those of the St. Paul & Pacific and of the Red River Transportation Company extended the same favors during the progress of the survey of the Red River water supply.

A considerable portion of the season has been spent in the northern half of the State. What has been done there has been of the nature of hasty reconnoisances. Nothing else is possible. The means now available for the survey will not warrant the commencement of detailed surveys in a region mainly without roads and but sparsely inhabited, however great the need of geological examination. It is mainly for this reason that the survey has been carried on during the past six years in the southern portion, where, at much less expense, the utility of the survey could be demonstrated and its progress be more evident; as it is well known that geological surveys have, in various states, come to unfortunate interruption, and sometimes final termination, for causes immediately political or economical. The time has come, however, when it will not be prudent nor just to further ignore the northern half of the State. An unusual impetus in immigration, and in prospective mining, has stirred the people in that part of the State, during the past year, to make serious demands for the services of the Geological Survey in exploring and developing their material resources. The enterprise of the government of the Dominion of Canada on our northern frontier, in the building of railroads and canals, will not fail to react powerfully on the State of Minnesota north of Lake Superior. The Canadian geologists have already visited and reported a number of times on the contiguous portions of the British Possessions. It seems to be very necessary to subject that part of the State to a thorough geological survey; but it will require expensive outfits for two or three exploring parties, and it would be several years before the survey could progress sufficiently to warrant a final report. Meantime, during the progress of the work in the northern part of the State, investigations should not be suspended in the southern portion. In order to carry on the survey now as it seems to be necessary, an additional sum of six or eight thousand dollars per annum, for about four years, should be available. It would then be possible, probably, to issue a couple of volumes of a final report, one on the southern palæozoic formations, and one on the metamorphic and azoic rocks of the northern portion of the State.

II.

THE WATER SUPPLY OF THE RED RIVER VALLEY.

The State law by which the survey is being carried on requires a complete account of the mineral and other waters of the State, including accurate chemical analyses. It was at the instance of the Secretary of the State Board of Health that the immediate examination of this region was undertaken; the sanitary questions involved being regarded of great importance. With a view to the co-operation of the Regents and the State Board of Health in this examination, a joint party was organized, consisting of the State Geologist, with Prof. S. F. Peckham on the part of the Regents, and Dr. C. N. Hewitt, Secretary of the Board of Health. The plan of procedure consisted in a descent of the valley from Breckenridge, on the St. Paul & Pacific Railroad, to Winnipeg, in Manitoba, stopping at the principally settled points for information concerning the objects of the survey, examining all accessible wells and procuring samples of water, and carefully noting the nature of the river bluffs. Subsequently, and during the further prosecution of the field-work over the western portion of the State during the season, more extended observations on the same subject were made by the State Geologist outside of the Red River valley, and the valley itself was again visited for further facts of comparison and verification. The conclusions arrived at in this report are based on all the facts observed; and as they vary somewhat from opinions advanced by other members of the party, it is but just to relieve them from all responsibility for them. Soon after the return of the party a summary of these conclusions was prepared at the instance of Gov. J. S. Pillsbury, and it was published in the *Pioneer Press* for September 18, 1877.

It is also necessary to state that the samples of water selected for analysis were not such as would test the correctness of these conclusions, nor that of any theory that has yet been advanced for the cause of the foul waters of the Red River valley. In order to determine something by chemical analyses of the waters, the writer selected and urged the full analysis of four samples only, with qualitative tests for other samples to show their relations to either of these, viz.:

1. Some simply alkaline water from a deep well.
2. Alkaline water from some deep well contaminated by organic decay.
3. Water from some shallow well uncontaminated by organic decay.
4. Water from a shallow well foul from organic decay.

The analysis of water from the following wells, conforming to the conditions required by the above varieties of water, was recommended for the purpose of arriving at some satisfactory result. It is to be hoped that the survey may be able at some future time to institute further examination, and chemical analysis, should the explanation here given not prove sufficient.

1. Water from the Brewery at Moorhead.
2. Town well at Breckenridge.
3. McHench's cistern well at Fargo.
4. Well at Mr. Sloggy's house (not the Bramble House.)

The Facts Known Before the Survey.

The flat prairie country generally, throughout the western portion of the State, has been much troubled by bad well water. This has been reported to the survey from Lyon, Renville, Redwood and Murray counties, in the southwestern portion of the State, and had by the parties troubled by bad water been attributed to a so-called "peculiar clay," a "blue clay," a "black clay," or to some other deposit in the drift which had been met with in the wells. Similar reports had come from the country further north, and latterly from the Red River valley specially. The settlement of the Red River valley has been rapidly going on during the past two years, and these difficulties were more numerously and urgently presented from that quarter of the State. As these waters had a very deleterious effect on the health of the people, and threatened to retard the development of that portion of the State, the State Board of Health very wisely initiated the systematic examination of the whole question which is now being made, but directed itself specifically to the valley of the Red River of the North. The waters from the wells dug, whether deep or shallow, have been found to become foul, or "stagnant," sooner or later, and if their use has continued much beyond the discovery of this condition they have produced diarrhœa of a persistent nature, and finally typhoid fever. Some cases have terminated fatally. These facts were of occurrence on the line of the St. Paul & Pacific Railroad, at nearly all the stations west of the line of the Big Woods, even outside the valley of the Red River; on the Northern Pacific Railroad west of Detroit; along the same railroad in Dakota, and down the valley to Winnipeg. These effects were known also south of the Minnesota river, but they have not been attributed so directly, so far as the writer is aware, to the water used for domestic purposes. Yet typhoid fever and intestinal diseases have had, during the past ten or fifteen years, an area of greatest prevalence in western Minnesota and Iowa, according to the ninth United States census. The ascertained relation of cause and effect between bad well water and these diseases in one section of the State, together with the known existence of the same effect in another section under like conditions of soil, climate and surroundings, reasonably leads to the inquiry whether the same cause has not prevailed there also, though it may not have been so distinctly recognized. Another fact that had been stated and well authenticated before the beginning of the survey, was the good quality of the water when the wells were first dug. It has also been stated that during the construction of the railroads that cross that portion of the State, a number of shallow wells were dug in the surface of the prairie, without reaching much water, and that they often became foul in a few days, though wholly uncurbed.

The Wells that were Visited and Examined.

The following facts were gathered by the writer:

Morris.—At Morris, in Stevens county, which is on the Pomme de Terre river, a tributary of the Minnesota, and not within the valley of Red River, the wells are usually bad, and the people generally use the water of the Pomme de Terre. Wells have to be dug rather deep, and through a blue hard-pan. The railroad company are now boring a well having a diameter of sixteen inches. They turn a sort of auger by a single horse-power, and take out the clay as an auger takes out wood, but it has to be lifted out frequently. The material thrown out, now at the depth of 56 feet, is a blue clay with few stones, but some small gravel. No water has been met with yet.

According to Mr. Leonard B. Hodges a well of good water was obtained at Morris later in the season of 1877. It is owned by Judge L. E. Pierce. It is surrounded by foul wells, several of about the same depth, and others of not half that depth. It is in every respect like many other wells at Morris, except in not having wood curbing. It was "driven," *i. e.,* after digging some depth an iron pipe with protected sieving was driven into the clay till water was found which rose in the pipe. This well was good and has remained so.

St. Gabrielle Springs. NE¼ Sec. 17, T. 130, 45.—Three miles from Campbell station, a little south of east. Here are St. Gabrielle Springs, said to furnish "good water;" but although there is a scummy deposit of iron running from them the water tastes alkaline, and is very much like the water of the deep well at the station. There is a boggy area of about two and a half acres, lying a few feet above the water of the stream (Rabbit river) from which the water of the springs runs into the creek. This area is in a bend of the stream, and lies about six feet below the general level of the prairie. The stream is about twelve feet below the prairie, and empties in Bois des Sioux river. It is a small stream and has clear water, but an imperceptible current. In some of the springs which are scattered over the boggy area mentioned, there is a light-colored sand seen boiling up with the water, and in the sand are also some weathered small shells. The bog itself is peaty, and shows some small fresh-water shells. The banks of the stream show nothing but the usual gray drift-clay, containing boulders of granite and many pieces of limestone. The water of the creek tastes swampy and flat. The stones and the gravel of the drift, along the low bluffs of the creek, are mainly of limerock—perhaps three-fourths of them, the rest being granite, &c.

Over the surface of the prairie about, which is nearly flat, are occasional fragments of limestone, which are usually somewhat imbedded in the surface, showing the *glacier origin* of even the latest part of this flat. There is no loam here, nor stratified fine clay. There is only a gravelly or stony clay that is blackened at the surface. On making a few qualitative tests on the spot on the water of this spring, for comparison with that of the water at Campbell Station coming from the deep well there (next mentioned), it was found to agree, even by actual comparison in hand, almost exactly with the water of that well. They both possess abundant sulphates, carbonates strong, and plenty of chlorides. The only perceptible difference in mineral constituents was a little greater quantity of iron in the well water. On making quantitative examinations Prof. Peckham reports these waters to contain impurities as follows:

	Total mineral matter.	Organic and Volatile.	Total residue at 30° C.	Removeable Hardness.	Permanent Hardness.	Total Hardness.	Chlorine.	Suphuric Acid.	Lime.	REMARKS.
2.	62.458	12.316	74.764	10.216	15.468	25.684	10.623	4.202	6.647	These waters show a very remarkable similarity of mineral constituents.
3.	55.454	12.481	68.295	8.756	11.960	20.722	No Estimate	5.370	6.864	

As the water at the station is foul and unfit for use, while that from these springs is pronounced good, and even has a reputed excellence, both waters coming through the same natural drift deposit, subject to the same natural causes so far as their source is concerned, while the spring water itself is free from noxious odors, it is evident the difference of the waters cannot be indicated by chemical analyses of the mineral constituents. It is also evident that the difference, whatever its nature or origin, must be superinduced by some *artificial*, and not natural, cause ; in other words, that there is something inherent in the well, or its artificial surroundings, that superinduces the noxious odors. The trouble, further, cannot lie in the clay of the drift, since the spring water is constantly in contact with the clay, and the well water is brought up through an iron pipe which is said to run to the bottom.

Campbell Station.—The well at Campbell Station was sunk several years ago by C. E. Whelpley, of Minneapolis. The following section of this well was furnished by him July 19, 1875 :

1. Hard yellow clay with strong bitter water.... 18 feet.
2. Blue clay.... 53 feet.
3. Boulders, or rock of some sort.... 4 feet.
4. Blue clay.... 39 feet.
5. Blue clay, boulder, gravel and flint.... 11 feet.
6. Sand, gravel and clay, with some coal.... 21 feet.
7. Sand, gravel, blue clay, slate, some coal.... 4 feet.
8. Hard blue clay.... 15 feet.
9. Clean sand with water, mixed with coal (10 per cent.).... 8 feet.
   [NOTE—This coal on examination was found to be drift pieces of Cretaceous lignite—N. H. W.]
10. Stony blue clay, but softer below, with more water at the bottom.... 87 feet.

Total depth.... 260 feet.

The lower portion of the pipe becoming filled with mud it was found necessary to puncture the pipe at higher levels and admit water above the clay filling. This was done at 176 feet. The water rose within four feet of the surface.

At the depth of 173 feet found wood which was covered with a yellow substance like gold (probable pyrite—N. H. W.) and was heavier than water. Water was obtained at 125 feet, and again at 150 feet, also at 165 feet.

The water pumped out of this well in June, 1877, was turbid with sediment and visible floating particles, and had foul odors. It could not obtain these foul odors from the bottom of the well, nor furnish these floating particles from that depth, since they were evidently both of organic nature. The upper ten or fifteen feet of this well were dug larger than the rest and curbed up with pine boards after the manner of most wells on the prairie.* This was partially filled with water and served as a reservoir. This water must certainly find access within the iron pipe, either through intentional rupturing of the pipe, or loose fitting of the pipe upon the lower joint of the pump. It otherwise passes along the outside of the pipe, between the pipe and the surrounding clay, to the bottom of the well, and is drawn into the pipe at the bottom. This last supposition is hardly possible, as the closeness of the clay about the pipe is probably as perfect as about any stone or boulder, and must be as impervious. Further the surface water would not thus naturally flow downward, being warmer and lighter, as well as being under less hydrostatic pressure, as long as there remained a supply for the pump within the pipe.

About a mile northwest of Herman the railroad passes down a terrace to a lower flat, the change of level being about fifteen feet. Hence the well at Campbell Station, wholly dug in the glacier drift, without any overlying stratified clays, cannot be affected by any lacustrine clay that seems to have been deposited over large areas in other parts of the Red River valley. The glacier drift itself, over wide tracts in this valley, lies at the very surface.

At Breckinridge.—At this place, which is near the junnction of the Otter Tail and Bois des Sioux rivers, the grade of the railroad is just twenty feet lower than at Campbell Station, and a hundred and six feet lower than at Herman Station. The distance from Breckenridge to Campbell Sta-

*On inquiry of Mr. Whelpley concerning this well he affirms that no wooden curbing was used in the shallow preliminary digging, the only design being to get room to enter his pipes, and that the dug part was almost entirely refilled, leaving but a shallow basin round the pipe at the surface.

tion is fifteen miles, and from Breckenridge to Herman is thirty-nine miles; the country in all directions being a smooth prairie for many miles, with no visible changes except at the terrace mentioned, near Herman. Yet at Breckenridge, along the river banks, are broken areas of true lacustrine clay. This runs back from the river and covers a small indefinite area. It seems to have been deposited on a slightly uneven upper suface of glacier clay, or unmodified drift, so that it here only occupies the depressions in the glacier clay.

The town has five wells, but only one is used. It is the hotel well, owned by Mr. Sanders, who described it as follows. It is curbed with boards.

Sanders' Well at Breckenridge.

1. Mucky, black soil, no stones	2½ feet.
2. Fine clay, without stones; the same as seen in the river banks	16 feet.
3. Gravel—small pieces of limestone, and granite boulders, with some layers of clean sand	10–12 feet.
4. Under the last, which furnished water, was an unknown thickness of a black or blue-black clay, that had a different odor. This contained stones and boulders, one of which stopped the further sinking of the well, which, however, did not penetrate it to any considerable depth.	

The water of this well, analyzed by Prof. Peckham, shows the following composition, as reported by the Secretary of the State Board of Health:

	Grains per Gallon.
Total solid matter in solution	86.024
Total organic matter in solution	12.286
Total mineral matter in solution	73.756
Total hardness	19.843 $CaCO_3$
Permanent hardness	8.756
Removable hardness	11.387
Sulphuric acid in solution	1.868
Chlorine	17.395

These results show a general resemblance to those of the well at Campbell Station, and the water of St. Gabrielle Springs, containing nearly the same per cent. of the various mineral peculiarities.

The town well was mainly a bored well, but is curbed with pine boards. The water here varies. Sometimes it has been pretty good, especially at the first, but at the time of this examination it was strongly charged with sulphuretted hydrogen. It is in the street, and near no sewers. The ground was raised about the mouth of the well to prevent in-drainage from the surface.

Town Well at Breckenridge.

1. Soil and clay. .... 4 feet.
2. "Black clay," &c., with gravel stones, no water........... 30 feet.
3. Gravel and sand, with water in abundance, that rose 16 feet in a few minutes........................Thickness unknown.

On analysis this was found to be a very hard mineral water, containing large percentages of sulphates of lime and magnesia, but "on evaporation had the appearance and odor of urine residue." This water may be taken as a type of the waters derivable from deep wells that penetrate the glacer drift-clay, when not materially changed by contact with organic acids.

The well of Peter Hanson was dug entirely, 3½ feet square, and curbed with pine boards. The material thrown out is unmodified drift-clay, of a dark-blue color, containing stones and boulders, some ten and fourteen inches in diameter, which show smoothly polished and also striated surfaces. The clay itself is nearly black when wet, and is charged with little stones. This well did not pass through the drift clay, and now affords only "seep water," which, after a month or two, will about half fill the well. It then has a foul odor which is attributed to the "black stuff," as the drift-clay is designated.

Peter Hanson's Well at Breekenridge.

1. Clay, as in the river banks; fine and horizontally stratified..4–5 feet.
2. Drift clay, dark colored, hard and strong, no water, penetrated... 50 feet.

The well of Chas. B. Falley, Esq., is altogether in the lacustrine clay. It afforded pretty good water at first, but in a few days it became offensive.

C. B. Falley's Well at Breckenridge.

1. Black loam soil..4 or 5 feet.
2. Light colored clay, with some sand, without stones, crumbling in the air.................................... 24 feet.
3. Sand with water (17 feet of water)...........Thickness unknown.

From Breckenridge the river was followed in a small row-boat to McCauleyville, opposite Fort Abercrombie, for the purpose of carefully examining the banks.

Section 21, Town 133, Range 47, Wilkin County.—Mr. Edward Connelly has here a well twenty-five feet deep, in which the water rises and falls as the river changes, indicating an intimate connection. The well is near the brink of the bank, which rises about twenty-two feet above the river. The bank is made up of about eleven feet of gravelly and stony drift clay, without any overlying lacustrine clay, underlain by a heavy bed of gravel and sand exposed along the bank a short distance above his house. Mr. Connelly also described his well as penetrating these materials only. In this gravel are pieces of Cretaceous lignite and slate. The presence of this gravel bed, and the rising and falling of the water of the well coincident with that of the river, proves a close relation between the two, but not a flow necessarily from the river to the well. There is not much doubt that the gravel bed is itself a vast water-reservoir, which is being filled by inflow from higher levels, and is slowly drained toward the river by hydrostatic pressure. The analysis of this water rather goes to show this to be the direction of flow, since there is much more mineral matter in the well than in the river water, a change that could not be produced by simply filtering through gravel for a few feet.

Descending the river below Connelly's, the light-colored, lacustrine clay, mentioned at Breckenridge, is seen to become more and more developed. and at last continuous, with a thickness of 25 or 30 feet, equal to the hight of the entire banks above the river, with only occasional exposures of the hard-pan clay near the river level. The hardpan finally disappears about two and one-half miles above McCauleyville, near "Aker's place," the last exposure being near the rope ferry. Below this place the lacustrine clay constitutes the entire bluff of the river. Before reaching this place the large boulders, which appeared frequently in the river for some miles below Breckenridge, had entirely disappeared. At the same time timber along the river becomes more and more abundant, and also larger. At first it consisted almost entirely of willows and box-elders, but as this change comes on large trees of white and burr-oak, ash, elm, bass and hackberry make their appearance. The bottom lands widen out, and at the same time become higher, reaching 15 feet above the water, while the lacustrine clay bank, outside of the bottom land, rises about 15 feet still higher. This lacustrine clay covers the country generally, east and west, especially up the tributary valleys; and it is plain to be seen that it will constitute a different agricultural land from the alkaline plain further south, based on the drift-clay.

There are here then these three formations, all pertaining to the drift:

1. Latest of all, *the alluvium* of the present river, which is mainly sandy, and supports the timber. It is without stratification generally, and swallows burrow in it. Its thickness varies with the hight of the freshet stage of the river, becoming greater toward the north.

2. The *lacustrine clay*, which covers the higher flats, and constitutes the soil of the valley over much of this region. It is of a light and loamy color, horizontally stratified, and is without stones or gravel. This is the sediment of the lake which was drained by the Minnesota river southward during the prevalence of the last ice-period, or on its partial withdrawal.

3. *The blue hardpan clay*—The immediate product of the great glacier, containing gravel stones and striated boulders. This fills the whole valley, running under the lacustrine clay and rising so as to constitute the surface of the country a few miles east or west of the river, becoming rolling, and even hilly, in the Leaf Hills and Coteau de Prairie, but lying smooth and level in the valley. This may have been originally deposited nearly level and smooth, as it now lies, owing to the presence and agency of much standing water, or it may have been somewhat smoothed off at a later date by the lake that covered it. This whole region, then, and especially the general aspect of the flats at Breckenridge, are a fac simile of the Maumee river and the "Black Swamp" region of northwestern Ohio, minus the timber and plus the alkali of the drift clay. Its origin was the same, and probably also its date, both pertaining to the period of the last glacial epoch. The theory advanced some years ago for the manner of deposit of this glacial drift*, here is confirmed by being equally applicable. It was received in these valleys, in a lake of water direct from the ice, and was let down gently without much modification, and stratification as fast as the ice sheet contracted; the horizontally laminated clay, in both places being the result of such lateral distribution of the clayey portions as the lake could effect, and of such later lacustrine deposit as water is apt to form, during its continuance as a lake. Further to

*Proceedings of the American Association for the Advancement of Science, 1872—*The Surface Geology of Northwestern Ohio.* Also the Popular Science Monthly for June and July, 1873—*The Drift Deposits of the Northwest.*

the north it covered the surface of the glacier, but by degrees became embraced further still north, in its general mass, and extended even to the bottom of the ice. It became superficial near the margin of the glacier by the thawing and wastage of the upper surface of the ice.

McCauleyville—James Nolan's well, 32 feet deep, affords a strongly alkaline water. It is situated on an irregularly ascending slope from the river toward the general level, and six feet below the general level. It was bored 17 inches in diameter.

Nolan's Well at McCauleyville.

1.	Soil and black loam	2½ feet.
2.	Brownish-yellow clay, with no noticeable stratification, nor gravel, nor stones	26 feet.
3.	"Black sand," quicksand	4 feet.
4.	Gravel, shells, and rounded stones, like the bottom of a lake, with water, went into it	1 foot.

This well seems to have got water in a layer of sand and gravel lying between the lacustrine clay and the hardpan clay, but on analysis it is proved to be heavily charged witn alkaline ingredients.

Langevin's Well at McCauleyville.

1.	Loam and soil, and light clay	15 feet.
2.	Blue, gravelly clay, with boulders, containing one layer of sand and gravel of 3 feet thickness, at the depth of 40 feet. No water of any amount was found in this well, and it was refilled. This blue clay had pieces of coal and Cretaceous slate, and granite boulders. The sand layer gave offensive water. At about 100 feet there was a layer of about 6 feet of very fine blue clay which makes a good polishing material	122 feet.

It is possible, if not probable, that in the foregoing the lacustrine clay assumed a blue color after passing 15 feet, and thus really extends to the layer of sand and gravel mentioned at the depth of about 40 feet, and which is said to have given offensive water. The absence of gravel and stones in the upper part of the "blue clay" was not, in that case, carefully noticed, and the color being the same would very naturally cause it to be set off with the great mass of stony blue clay lying below it. This hypothesis is all the more likely, as the offensive water from the sandy layer may then be due to the vegetation and muck that would have accumulated in the bottom of the lake which immediately followed the deposition of the stony blue clay—a lake bottom which is also indicated by Mr. Nolan's well at about the same depth below the general level.

In digging Mr. David McCauley's cellar a large deposit of bivalve fresh-water shells was encountered. Other shells were found in digging the cellar of Mr. Longevin. These cellars are far above the river, and yet not so high as the general level of the country. These shells of course belong to the period of the lacustrine clay, either during or following the last glacial epoch.

There are said to be two terraces east of McCauleyville. One is four miles east, and consists of gravel, and one is thirteen miles east and consists of sand. There is a depression, or longitudinal basin, running north and south, between these terraces, in which water stands some years all summer.

At and below Fort Abercrombie are large and numerous selenite crystals. They were found by Mr. Nolan about three miles below the fort, in the slope of the bank of the river, and by the soldiers near the fort in digging a well. They are said to have occurred, in the well, above a heavy deposit of boulders: hence seem to be in the drift, and not in the Cretaceous.

Moorhead—In riding over the prairie from McCauleyville to Moorhead, a distance of about 30 miles, sometimes several miles east of the river, only seventeen granite boulders were seen on the surface. These were from six to twelve inches in diameter, and were entirely solitary, being generally half buried in the soil. There was seen no gravelly clay, nor small stones in clusters, nor any alkaline coating, all indicative of the drift clay, throughout the whole ride, but only a fine clay loam.

The well of C. P. Sloggy, at the Bramble House, is 22 feet deep, and wholly in the lacustrine clay, having struck at that depth a quicksand three or four feet thick, giving water. This well was recently dug (in May) and the water is tolerable, though evidently alkaline, and having a taste of the pine curbing. It is, however, less alkaline than water from the hardpan clay. It is said that there is a layer of sand all over this country, including Moorhead and Fargo, at about 22 feet, in which the same water can be got.

The well dug by Sharp and Douglas, situated in the public park, is across the street south from the last, and has the same depth. It now tastes (June 23, 1877,) as if kerosene had been poured into it. It was dug about a year ago. The kerosense taste is owing to the decay and discharge of the pitch of the pine curbing, and will probably pass off.

Mr. Sloggy has another well dug to this layer of sand about a year ago, about two blocks further south, situated in the street, in an unfrequented part, which at first had a flow of good water, but finally became bad and had to be abandoned. On examination this was found to have the odor of decaying organic matter, and even of animal matter. It has been in disuse and shut for some months, the tight pine curb rising about 20 inches above the ground and covered with a board nailed over it. Hence the contamination cannot come from dead frogs nor rats, nor yet from sewage nor from surface indraining. Like most of the wells in the town the surface of the ground is elevated about the well, by throwing back round the curb the clay excavated in digging.

At John Erickson's Brewery is a well 105 feet deep, dug about two months ago (April or May, 1877). This well is used at the rate of 15 or 20 barrels per day. It is curbed with pine.

The Brewery Well at Moorhead.

1.	Light clay	20 feet.
2.	Quicksand	4 feet.
3.	Blue clay with gravel and boulders	80 feet.
4.	Sand, with copious water	

The water from the bottom of this well was under such hydrostatic pressure that it lifted up bodily "about two feet" of the entire clay bottom of the well, and rose immediately about 80 feet in the well. The water is strongly alkaline, but bright and clear, and is used for beer-making in preference to that of the river. This well was too recently dug, and is too copiously used, to show any markedly bad effect from the pine curbing.

The well of Lamb Bros. is sixteen feet deep, situated under the floor of a livery barn. It is curbed with pine. The water has an alkaline taste, which is said to be "sweet," and is very copiously used. It has never been noticed to be offensive, but will not do for washing. The clay here was but six feet thick, and the sand is said to have been ten.

Jacob Thomas' well is 14 feet deep, curbed with pine, smells and tastes of decaying organic matter, but not strongly of alkali.

Fargo—The well at the Fargo House is 25 feet deep, and the water is now good—as good as any water. It was dug one year ago, and is curbed with pine. Probably the fermentation took place last season. Indeed, a gentlemen who was at the house at Christmas affirms it was not so good then as now; yet the landlady, who probably would not notice a gradual change in the water, says it has always been as now; although she also admits it did "taste of the pine and was cleaned out." Another gentleman says it was not used for a time.

The well of J. C. Winslow is 25 feet deep, lately dug and just furnished with a pump. It is a good water also, as good as any hard water. The well is curbed with pine. For a time it was unfit for use.

At the Sherman House is a shallow well, dug four feet square, curbed with pine, has plenty of water which rises about ten feet, and is absolutely horrid with effete vegetable matter. It was dug last year, but has been in disuse for some time.

The well at the livery barn of A. H. Moore is a shallow well. It is curbed with oaken barrels and furnishes pretty good water, but has a pine pump running below the curbing. The water gives off a little sulphuretted hydrogen, but much less than the well at Mr. Moore's house.

The well at Mr. Moore's house is 96 feet deep, curbed with pine. It is an alkaline water, and has a strong odor of sulphuretted hydrogen.

Mr. McHench's well was dug for a cistern and is about 12 feet in depth. It is bricked up and cemented. The water broke in at the bottom and has always been good.

Mr. Roberts' well, near Fargo, is a shallow well, and smells very bad, but was very good at first. It has a pine curb.

A number of other wells were examined at Moorhead and Fargo, but the facts were only a repetition of the foregoing. They were all shallow wells, curbed with pine, had good water at first, and after a few weeks or months became foul and had to be abandoned.

The lacustrine clay is thinner on the Moorhead side than on the west side of the river, and wholly disappears a few miles east of Moorhead, the alkali of the hardpan clay appearing in low exsiccated spots. This occurrs before reaching the south branch of Buffalo river.

On visiting Moorhead again later in the season (September 1877) some of the wells that were unfit for use in June were found somewhat improved, especially those that had been copiously pumped. The Bramble House well was not improved, but rather had become worse. Mr. Sloggy referred to the well of Mr. Mangus Peterson as a curious illustration of the fickleness of the water in the Moorhead wells. This is situated only across the street from his at his house, dug about the same depth (26 or 27 feet) and is curbed like his with pine, but affords the "best water in the town." This seemed to imply that the fault is not in the curbing. On examination of this well it was found, as stated, to afford as good water as Mr. McHench's in Fargo, and was dug in September, 1876. It had been so foul that it was not used for several months. This summer it was emptied repeatedly and began to improve. The neighbors also began to use it, so that it soon acquired a reputation for its excellence. In this case the copious use of the well is what renders the organic impurities imperceptible. By standing it will probably relapse into as bad a condition as before.

Glyndon—At Glyndon the wells are all alkaline, and also generally about sixteen or twenty feet deep. They pass at once into the hardpan clay. They are all curbed with pine. Only one is now fit for use. It is that of the house lately purchased of Major Tenny by James McLenan for use as a hotel. This does not taste of organic decay, but is strongly alkaline. The well at the present McLenan House is very foul, but the former is freely used by the whole village. The well at the Campbell House is not used. It is very heavily charged with organic decay in its foulest stage, and has been in disuse much of the time for four years. Though cleaned out about a year ago, and used slightly for a few months, it is still unfit for use. It is within a few rods of the above named well which is used by most of the families of the village, and has about the same depth. Water from the well in general use was examined chemically by Prof. Peckham, and compared with a similar examination of that from the Campbell House, without showing any important difference in the impurities contained in solution. They are both hard waters. While from one is escaping constantly a volume of noxious organic odors, including sulphuretted hydrogen gas, the other is wholly inodorous, and is freely used for all domestic purposes. It is plain that there is something in the surroundings of the wells which causes the difference. They are both curbed with pine and were dug some years ago. It is also probable that the copious use of the one keeps it substantially inocuous, while the disuse of the other intensifies the foul qualities. That in constant use is a large open well. That which is foul may be confined and covered. It is also evident that the bad qualities of these wells cannot be detected by the ordinary chemical examination of their mineral impurities. In other words, the foul odors arise from organic ingredients which are volatile. There is no other supposable cause for these odors adequate to the explanation of so prevalent a disorder, than to attribute them to the decaying pine curbing which is co-extensive with the disorder.

There are several other wells at Glyndon, but they are all bad from the same cause. They are sunk in gravelly clay, and get water in gravel.

The well at the Round House, situated somewhat west of the village, was dug in 1872 by the St. Paul & Pacific Railroad, and is reported as follows by Chas. A. F. Morris, who was Chief Engineer when the well was dug:

Round House Well at Glyndon.

1. Black soil	1 ft. 3 in.
2. Yellow quicksand	12 ft.
3. Blue quicksand, sheets of turf and vegetable deposits	3 ft. 6 in.
4. Blue clay and drift wood	2 ft.
5. Blue clay	2 ft. 7 in.
Total depth	21 ft. 6 in.

This section is interesting, as it reveals a layer of drift wood 18 feet below the surface. While this was probably deposited by the current of Buffalo river, which runs near Glyndon, during some earlier history of its channel, which then must have occupied a different position from what it does now, it may still be due to water-logged drift wood that was gathered along the shore of the ancient lake that once extended to or even beyond Glyndon. The character of the material overlying the drift wood ("yellow quicksand") strongly indicates the fluvial rather than the lacustrine origin of the drift wood. Its not having been discovered at other points is cumulative evidence of its not extending generally under the country about Glyndon, as it would be more likely to do if of lacustrine origin. Hence it is not likely that the bad odors of the wells there are attributable to vegetable decay from that source. If it were demonstrated or admitted that vegetable decay is the cause of these odors, it would be folly to overlook the chief known source of such contamination (the pine curbing) and search for it in the soil or clay, or buried drift wood.

At Fisher's Landing, just below Crookston, on Red Lake river, the grade of the railroad is made of gravel, rounded by water action, similar to that seen in a number of places along the road between Glyndon and Crookston, where wave-action has carried away the clay from the drift, and has left the gravel stones strewn over considerable areas. A double handfull of these pebbles, from one-half to one inch in diameter, picked up without selection, afforded seventeen of fine, compact limestone, and four of metamorphic rock. This shows probably an average proportion of limestone pebbles to metamorphic in the drift of the Red River valley in general; though it is probable the limestone pieces would be more numerous still further north, and less abundant toward the south. These limestone pieces are strewn with the drift all over the western portion of the State, even to the Iowa state line, large pieces sometimes being found in the southern tier of counties. They come from the Winnipeg limestone.

Winnipeg—By the courtesy of the officers of the Red River Transportation Company the party were taken to Winnipeg and there made further examinations.

Connell and Burke's well, dug about a month, is 56 feet deep. The water was at first good, but now has a faint taste of sulphuretted hydrogen. This may be attributed to the wood curbing placed in the well, which is of spruce. The well went through 40 feet of fine brick clay, and 16 feet of stony clay, with boulders of granite and limestone.

Wm. Hespeler's well on a lower terrace level, dug three years ago, was used last year by two water-carts in distributing water throughout the city, and was good, but now it is little used, and has a sulphuretted taste. It passed twelve feet through brick-clay and obtained water in quicksand; has pine curbing.

Wm. Hespeler's old well, on the same level, dug four years ago near the last, formerly had a sulphur taste, but now furnishes a beautiful cold water. It is also twelve feet deep. It has a pine curbing.

Thos. Maxwell's well is near the last two; was dug this spring, and furnishes perfectly good water. It is the same as the last two in all essential particulars, except that it is copiously used by three water carts in delivering water in the city. Its depth is also a little greater, but the water is from quicksand. The overlying clay was found to be, as in those, about 12 feet. No stony clay was met with in these wells.

The Messrs. Chambers Brothers have just completed a well, and put in wooden curbing. It is on the upper flat and 57 feet deep, much of the depth being in a stony clay. The water is alkaline, and as yet has no taste of sulphuretted hydrogen, or organic odors.

The well at the Union Hotel is "sweetly alkaline." It is just dug, has a wooden curbing, and is 57 feet deep; in gravelly clay.

The well at the Free Press building was dug four years ago, and is 59 feet deep. The water is alkaline and sulphuretted. The well is curbed with pine, which still affects the water. The water rises from a gravelly clay deposit near the bottom, and stands within ten or twelve feet of the surface. It is not much used.

[NOTE—The first well of Mr. Hespeler, mentioned above, is at the Orilla House. It is near a barn, with a manure pile very near. It was foul, and on being cleaned two or three dead gophers were taken from it. His second well is at his brick block, but not more than forty feet from the first. It was also foul and "stagnant" last year, but on being more pumped became good again. The Maxwell well is between them and in a low barnyard or muddy spot. It is used by three water carts. The tight clay of which the surface consists seems to shed all surface impurities whenever the slope is away from the well. This is shown by the Maxwell well which, though favorably situated for surface indrainage, is perfectly free from these bad odors, and is largely used.]

The lime rock at Andrew's Rapids, twelve miles below the city of Winnipeg, is quarried and used for all building, and even as dressed cut-stone for large ornamental fronts. That at Rocky Hill, or Stony Mountain, where the penitentiary is built, 17 miles northwest of the city, seems to be of the same general age and texture, but is more fossiliferous and irregular. Its color is a light buff, or faded drab. It is in all respects, exactly like the boulders and gravel strewn so abundantly over western Minnesota.

At this place the lacustrine clay makes a cream-colored brick. Below it, or in it, is a sand layer, which does not seem to be everywhere met, which gives good water not perceptibly alkaline. The drift-clay below gives a strongly alkaline water. There are some artesian wells in this neighborhood which rise from below the blue drift-clay, or hardpan.

White Earth.—Mr. G. A. Morrison, of the White Earth Indian Reservation is authority for the statement that the same difficulty with bad water is encountered there. The wells are dug in the drift clay, and are all curbed with pine, with one exception. That also was at first, but the curb was taken out and stone walling was put in. The water was bad before the change, but now it is good.

Detroit.—Wells at Detroit enter gravel within twenty-five or thirty feet, and find a good lining and chalybeate water in abundance. Wells are curbed with pine. The country here is rolling, and the drift clay is very gravelly; indeed the gravel which furnishes the water of wells seems to rise to the very surface. No trouble with foul water.

Perham.—Here the soil is a loam, and the subsoil and drift are gravelly, allowing free underground drainage. Water is found at 20 and 30 feet. Some pine curbs have been used, but there has been no trouble with foul water. The supply is copious.

Brainerd.—Many of the wells curbed with pine at this place are foul in the same manner as at Fargo, Breckenridge, &c. Attention was directed to the fact by Dr. J. C. Rosser, of Brainerd, in connection with the occurrence of numerous cases of typhoid fever which had been attributed to the use of bad well-water. The soil here is sandy, with some clay, with a clayey sub-soil. In company with Dr. Rosser and Dr. V. C. Smith, of Duluth, the writer visited and examined about twenty wells. They were found to be all curbed or walled with pine. They have an average depth of thirty-five to forty feet and penetrate a stony clay deposit. They have mostly been dug for a number of years. The majority have a distinct taste of decayed wood, and are turbid with floating particles from the pine. The smell is not so rank as in many in the Red River Valley, and in most of them no offensive odor can be distinguished, though to the taste there is a distinct trace of organic decomposition. They seem to have a great deal of detached floating (or suspended) fungus growth, which is of a yellowish-brown color and inodorous. These wells are in what might be styled the second stage, or one of fungus growth and dead wood, which is a natural sequence of the rank and odorous stage which they first pass through. The occurrence of frequent cases of typhoid fever both at this place and in the Red River Valley, taken in connection with bad well-water in both places, was suggestive of the possible existence of a common cause. It was for this reason that Dr. Rosser desired an examination of the Brainerd wells. Three samples were procured for chemical examination. They were examined by Prof. Peckham with the following results :

Analysis of Well Waters from Brainerd.

Owner's Name.	Serial Number.	Total Solid Residue.	Mineral Residue.	Organic and Volatile Residue.	Permanent Hardness.	Removable Hardness.	Total Hardness.	Chlorine.	Free Ammonia—Pts in 100,000,000.	Albuminoid Ammonia—Pts in 100,000,000.	REMARKS.
C. H. Alsop...	49	32.287	24.283	7.004	8.172	6.44	14.593	42.728	132.	49.	Sulphuric and Carbonic acids, a trace.
Al. White.....	50	16.519	13.250	3.269	6.129	3.210	9.339	4.027	0.	0.	" "
Leland House.	51	37.241	30.937	6.304	9.923	4.378	14.301	50.900	26.	13.	" "

No. 49, above, was from a well used by a family in which there had been a recent case of typhoid fever. The water had been condemned some time before, and the well cleaned with the discovery of several dead mice; but since the cleaning the water had not been noticed to be bad again. The fever occurred after the use of the well subsequent to its being cleaned. At the time the sample was taken the well had been standing again unused, from the removal of the family, for a few weeks. It has a pine curbing. On visiting this well it was found to be perceptibly contaminated with organic decay, which was perceivable by the smell as well as by the taste.

No. 50 was from a well that was not known to have any bad taste or to have been accompanied, in its use, by any cases of fever, though curbed with pine.

No. 51, at the Leland House, there had been several cases of typhoid fever during the summer. Indeed, with the single exception of the case in the family of Mr. Alsop, all the cases in the town, (season of 1877) were confined to this house. The water from this well, which is in the kitchen and not well protected from surface indrainage, has a distinct odor and taste very much the same as those in the Red river valley, though less rank. This well is curbed with pine.

These analyses give abundant evidence of organic matters in these wells. The albuminoid and free ammonia can have no other plausible explanation ; but although at the present time their use is visited with typhoid fever, they are no worse than many others which were examined, and probably no worse than most of the wells of the place that are so curbed, during some former portion of their history. In former years this town has been severely afflicted with typhoid fever. At one house, formerly use as a hotel, it had been so common that the house was for some months a very hospital of typhoid fever, but now is not so much troubled. This well, however, is still bad from the same cause, but has passed its foulest stage. In other cases when these wells have been unused for some time, the odor becomes intensified; and it is a singular fact that familiarity with and use of the water renders it impossible to distinguish it, and even makes it agreeable. The most of the wells examined were said to have "good water" by the owners. Occasionally a man is found who says his well "tastes of the wood;" and also one occasionally who really knows that the water becomes foul from the pine, and recommends instead that *oak* be used.

In Mr. Follet's well, near Mr. Alsop's, the decay is just begun, the well having been dug this summer. It shows in iridescent films that float on the surface of a cupful, but does not now taste very bad.

Herman.—The deep well at this place was drilled by C. E. Whelpley, of Minneapolis, and the following record of it was furnished by him:

1. Blue clay	124 feet.
2. Rock	65 feet.
Whole depth	189 feet.

Water from the top of the rock rose to within six feet of the surface. There was considerable coal on the surface of the rock. The rock was very hard to drill and showed several changes within the sixty-five feet. The following letter may here be given pertaining to this well.

MINNEAPOLIS, MINN., 23d March, 1878.

C. E. Whelply, 1506 3½ Street South:

DEAR SIR:—I have just received your letter of March 22d, written at Herman, containing samples of rock taken from near the bottom of the well you are drilling there; in which you ask me what kinds of rock they are, and the probability of getting a flowing well by drilling deeper. The samples are as follows, as you numbered them, in descending order.

No. 1. "Found 124 feet under blue clay, seven or eight feet thick." This is the same stone as the limestone boulders that lie strewn over the surface of the Red River flats from Winnipeg to Big Stone Lake and beyond, and is found outcropping at the surface beyond the limits of Minnesota in Manitoba. It is a fine grained, buff, magnesian limestone, of the Silurian or Devonian age. Your letter seems to convey the idea that this lies in a layer seven or eight feet thick immediately over the rock of the next number. That would be anomalous and unexpected. It is very probable that this fragment is from a drift boulder, and that the thickness of seven or eight feet was occupied with a compacted boulder-mass, mostly made up of such rock. It is true that nearly all the boulders and gravel of the drift in that whole region are of this rock, and, according to a well known fact, boulders are much more frequent in the lowest ten feet of the drift than in any other part. * * * * * * * *

No. 2. This is a quartzose, granite, parti-colored by flesh-red feldspar. It is but a small piece, but is compact and fresh. It has but little mica.

No. 3. This is a white, micaceous quartzyte, in which there seems to be a little gray labradorite.

No. 4. This is a fragment of crystalline feldspar, with one rectangular cleavage, and a dull, vitreous luster,—an orthoclase.

No. 5. This fragment consists of glassy quartz and mica.

No. 6. Mica schist, with associated talcose rock.

No. 7. Mica schist with veinings of calcite.

No. 8. Mica schist, changed in color by heat applied since it was taken out of the well. (Same as No. 6.)

No. 9. Coarse mica schist. This came from a depth of 186 feet, and is said to have begun at 180 feet.

A glance at these samples is sufficient to show that your well is now in the metamorphic rock, the strata of which are discordant and highly tilted, and from which there are no instances of artesian overflows that I have ever heard of. All our artesian wells are in higher geological horizons. I should unhesitatingly discourage you from drilling any deeper in hope of getting a flowing well. These rocks are several thousand feet in thickness, and are followed by granites and syenites, in which there is no better chance of artesian water.

Very respectfully,

N. H. WINCHELL.

The Surface Geology of the Country.

It is not possible to give a full account of the surface deposits of the valley of the Red River of the North. This sketch will be confined to such general views as may be gathered from a hasty reconnoisance, based on such facts as an inspection of the banks of the river at numerous points and the examination of the foregoing wells have afforded. The full details will have to be filled in by subsequent and more elaborate exploration.

It is found that the lowest portion of the drift consists of a stony clay, which below contains more abundant gravel, and throughout many stones and boulders. It is also probable that many wells which have been supposed to have passed through it, have only struck water-bearing courses of gravel or sand in the clay itself. This deposit is generally blue. When it is at the surface it is lighter colored. The stones which it contains are from various formations, but about 75 per cent. of them seem to belong to the Winnepeg limestones. The rest of the stones are granitic. This clay also contains Cretaceous debris, such as slate and lignite. Such lignite sometimes is rather plentiful, and indicates that the Cretaceous formation, which is rather fragile and incapable of enduring long transportation, underlies large portions of the valley, if not the whole of it, and that the clayey portions of the stony clay have been very largely derived from the disintegration of this formation. This is further evinced by the occurrence of crystals of selenite in the drift deposits near Fort Abercrombie, the sulphate of lime being one of the alkaline salts that seems to have been abundantly in solution in the waters of the Cretaceous ocean. This vast clayey deposit of unmodified drift rises to the surface round the margins of the valley and spreads out in extensive flats, on both sides of the river, and between Breckenridge and Big Stone Lake toward the south. This flat surface passes by insensible degrees to one more rolling, and at the same time becomes more stony, toward the east, making the bulk of the Leaf Hills in Minnesota, and toward the west making the Coteau de Prairie in Dakota. It is essentially and typically a glacier-deposit, its varied aspects being due to the agency of water, present at the time of deposition, and either running with considerable current so as to wash out the clay and make stratified gravels and sands within the mass, as in the Leaf Hills and in the Coteau, or in the form of standing water, by which the clayey parts were retained and the whole spread out with a smooth upper surface, without much modification of structure.

After this drift clay was deposited there was for a long time a large lake of fresh water standing over the valley of the Red River of the North, which had an outlet toward the south by way of the Minnesota valley. This lake probably began its existence during the last period of ice, and was caused, at least during the latter part of its prevalence, by the glacier ice itself, which obstructed the northward flow which the natural slope of the country indicated and required. This lake began its existence on a much more restricted scale near Big Stone Lake, and it received and spread out evenly, as already noted, the glacier drift as fast as the glacier brought it forward. It grew toward the north as fast as the retreating ice sheet made way for it. At length, when there were partial or periodical openings in the northward outlet by way of Winnipeg, its shore line advanced or receded as the outlet opened or closed by the seasons of the waning glacial winter. Hence the fine deposits which it spread widely during the times of its highest stages were withdrawn by the receding beach line during the times of its shrinkage and partial discharge northward. Hence the lacustrine clay is not spread so widely as would be expected from the existence of beach marks at some elevated levels.

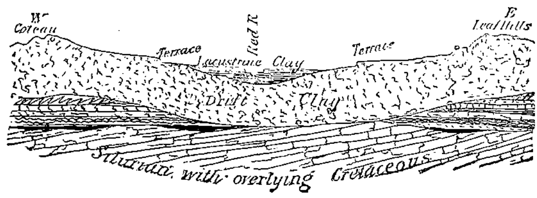
It was the water of this lake during its period of agitation and instability that produced the next noteworthy member of the drift deposits in the Red River valley. This is a layer of gravel and sand, sometimes containing fresh water shells in abundance, as at McCauleyville, which nearly everywhere underlies the lacustrine clay and affords water. This sometimes is several feet thick. It lies directly on the upper surface of the boulder clay, but it does not extend generally over that surface where the lacustrine clay is wanting.

The lacustrine clay is horizontally stratified, and contains no stones (at least none have been seen) nor gravel. It is fine and close. It is of a yellowish or earthy color; or at considerable depth it may be bluish. It makes cream-colored brick. It contains less of the "alkali" than the drift clay Its area is about twenty-five miles wide in Minnesota, but it extends westward into Dakota with about equal width, or perhaps greater, and runs northward into Manitoba with an increasing width and thickness. It is barely found south of Breckenridge. Its special location is along the river, covering a belt on either side, and widening east and west up the tributary valleys. But the most of the surface of the Red River valley, within Minnesota, seems to be formed of the drift clay, showing stones and gravel in abundance. There is not much doubt that this lacustrine clay was once spread more widely over the surface of the drift clay, and was removed by the action of the slowly retreating shore line.

The latest of the surface deposits is the alluvium of the river, which sometimes becomes a very important one. Its amount and area are greater further north. While this is generally an incoherent, amorphous and arenaceous deposit rich in vegetable humus, and is confined to the immediate valley between the bluffs formed of the older foregoing clays, yet there are some places where it is more compact, and has an undulating stratification that somewhat resembles that of the lacustrine clay into which it then seems to pass. Such cases are not common, however. It is this deposit that bears the timber that occupies the valley. It is much more abundant where the lacustrine clay forms the river banks than where they are composed of drift clay.

The adjoining diagram, representing a transverse section of the valley at Moorhead, illustrates the superposition of these parts of the drift.

FIG. 1.



Section across the Red River Valley at Moorhead.

The Chemical Peculiarities of the Waters of the Valley.

In general the waters of the entire valley are alkaline*, whether taken from wells, springs or running streams. That is to say, they contain considerable amounts of lime, magnesia and soda, combined as sulphates, carbonates and chlorides. They are not often very bitter, indicating a moderate amount only of the chlorides of calcium and magnesium, but they contain on the other hand not a sufficient quantity of sodium chloride to allow of denominating them saline. The soda is probably in the form of bicarbonate, with a small proportion ot chloride, the lime as carbonate and sulphate, and the magnesia as sulphate. Indeed the most predominant taste is that of sulphate of magnesia, or epsom salt. The waters of the valley are not equally affected by these mineral ingredients. Those

*The analysis of the "alkali" of the western prairies, taken from the south bend of Moose river, in Dakota territory, by Prof. E. H. Twining, is given in the report of the Superintendent of Public Instruction of the State for 1870. [Ex. Docs. of 1871.]

1. Coarse gravel, principally quartz	28 per cent.
2. Finer material, principally quartz sand	18 per cent.
3. Fine dust, (passes through a sieve of 80 to an inch	54 per cent.
Total	100 per cent.

COMPOSITION OF NO. 3.

Loss by ignition (water and organic matter)	3.99 per cent.
Insoluble in acids (principally quartz sand)	67.47 per cent.
Soluble silica	1.36 per cent.
Sulphuric acid	7.43 per cent.
Carbonic acid	5.98 per cent.
Lime ..... } Combined with Carbonic Acid	3.62 per cent.
Magnesia. } Combined with Carbonic Acid	1.18 per cent.
Potash	1.05 per cent.
Soda	6.18 per cent.
Alumina and Sesquioxide of irom	1.72 per cent.
Chlorine	Trace.
Total	99.98 per cent,

springs or wells that obtain their water from the drift clay are the most uniformly and strongly affected. Those whose source is in the lacustrine clay, or from the sandy layer between it and the drift clay, are much less alkaline, as a general rule, though it is not at all impossible that that layer should contain water derived immediately from the underlying drift clay, which would be as strongly alkaline as any directly from the drift clay. The waters freest from these mineral impurities are those found in the streams. Of these streams those will be found least alkaline that flow wholly or mostly over the lacustrine clay, and hence they are in the northern portion of the valley, where the lacustrine clay spreads wider. The water of the Bois des Sioux is purer (so far as these ingredients are concerned) than that of the Otter Tail. The former is the outlet of Lake Travers, and it is confined wholly to the immediate river valley, having only inconsiderable streams flowing from the drift clay surface. The Otter Tail, on the other hand, rises in the Leaf Hills, and flows for several miles, and nearly its whole course, over the alkaline drift clay.

These alkaline qualities are remarkably affected by organic impurities. In some of the natural waters of the valley this effect is noticeable, particularly in those which are sluggish. Some low grounds, in which vegetation grows rankly some portions of the season, but in which these alkaline waters collect and stand for some weeks or months during the early part of the following season, are offensive with sulphuretted hydrogen, while the waters themselves are foul and sickening. Such effects are due to the reaction of the decaying vegetable growths on the alkaline salts of the water, which converts the sulphates into sulphurets, which in turn are changed by the carbonic acid present, with the separation of free sulphuretted hydrogen, and the formation of carbonates. The small streams of the valley are also apt to be nearly stagnant during the summer season while they choke up with grass and other vegetation, and become heavily charged with organic matters. These react on the sulphates and materially affect the mineral condition of the waters, and their usefulness for domestic or agricultural purposes, They generally continue to be used for watering places for stock, and are sometimes hauled in barrels for household purposes. If these reactions are perfectly balanced by even portions of organic matters and alkaline minerals the soluble sulphates in the water may be wholly converted into insoluble carbonates, thus mainly freeing the water both of organic acids and of the usual mineral ingredients. But this is usually not the case. In the spring months, and during wet seasons, the alkaline ingredients overbalance the organic acids; but during the summer and fall, when the springs run low, and the developement of organic substances, and their decay, are most active, the organic impurities are in excess of the alkaline, and the waters show their worst condition —which is prolonged by the flatness of the surface, and the consequent slowness of natural drainage.

The waters of the valley generally do not have an offensive odor. It is only in stagnant and confined water these effects are noticeable. The chemical interaction is so slow that the resulting gas escapes unobserved, and the waters are slowly purified by the change. Suspended organic matter is also rapidly oxydized by contact with the atmosphere.

The following report of Prof. Peckham to Dr. C. N. Hewitt, shows more fully the chemical peculiarities of the waters of the valley from different localities :

Dr. C. N. Hewitt:

My Dear Sir—I have the pleasure of submitting the following report of the examination that I have just concluded of the specimens of water collected on our trip through the Red River Valley. They were gathered from the following named localities:

No. 1. The flowing well at Tintah, St. P. & P. R. R.
No. 2. St. Gabrielle Springs, near Campbell, St. P. & P. R. R.
No. 3. Well at Campbell Station, St. P. &. P. R. R.
No. 4. Otter Tail River, at Breckenridge, St. P. & P. R. R.
No. 5. Bois des Sioux, at Breckenridge, St. P. & P. R. R.
No. 6. Well at Connelley's, on river, four miles northwest of Breckenridge.
No. 7. Wild Rice River, west of Fort Abercrombie.
No. 8. Well at Nolan's Hotel, McCauleyville.
No. 9. Well at Brewery, Moorhead (Artesian).
No. 10. Well at Bramble House, Moorhead (surface).
No. 11. Well at Glyndon, good—in general use.
No. 12. Well at Glyndon, bad, McLenan's.
No. 13. Town Well at Breckenridge.

They were selected for the following reasons:

No. 1 was from a well that was dug only a few feet into the level prairie, which furnishes a stream of water constantly flowing over its brink. The water of this well is considered of fair quality, and is used at several of the stations on the St. P. & P. R. R. in that vicinity. It was therefore thought best to examine it.

No. 2 is from St. Gabrielle Springs about 2½ miles from Campbell Station on the St. P. & P. R. R., situated on the banks of a small stream called Rabbit River. These springs are the only natural outlet for water in that part of the country so far as could be learned.

No. 3 from the well at Campbell Station was represented as being very bad, and quite unlike either Nos. 1 or 2. As this well was quite deep and in the immediate neighborhood of 1 and 2 it was thought desirable to know in what respects they differed.

No. 4 is considered by the inhabitants to be the best water in the upper Red River Valley, and with No. 5 is extensively used along the banks of the two rivers. As these two waters in mingling form the Red River, it was thought desirable to ascertain their quality and their differences, if such existed.

No. 6 was selected because there was reason to believe that it was the river water filtered through beds of gravel which formed the river bottom at that point. It was thought desirable to know if such filtration removed mineral matter from the water.

No. 7, from a tributary of the Red River has a bad reputation. It was thought advisable to compare this water with that of the Otter Tail.

No. 8 appeared to be bad from excess of mineral matter, and at the same time it was different from the well at Breckenridge. For that reason it was thought best to examine it.

No. 9 was selected as representing the water of a very deep well, and No. 10 as representing the water of a shallow well from the same locality, that had been recently dug. It was thought best to compare them.

Nos. 11 and 12 were from two wells very near together and very unlike, one being considered very good and the other very poor. It was thought best to compare these and ascertain if possible why the water in the bad well should have become sulphurous.

No. 13 was the town well at Breckenridge. When selected it was supposed to represent the bad well water of that locality. It was probably much worse than the average.

The accompanying table gives the results of the examination of these specimens. In estimating the total mineral and organic constituents, 100 c. c. were evaporated over a water bath and when dry the residue was heated to 130 deg. C. in an air bath. It was then cooled and weighed, and the amount calculated as "total solid residue." This residue was then heated over a Bunsen's lamp and the organic matter burned off. The residue remaining was calculated as the mineral matter in solution and the difference as volatile and organic matter. This difference can not be safely computed as organic matter excepting in those cases when the mineral ingredients existed chiefly in the form of bi-carbonates. Sulphates in some instances and chlorides in nearly all, retain water at 130 deg. C. and when the amount of such salts is comparatively large, they prevent the complete combustion of the organic matter by fusing and enclosing particles of carbon. No. 13 may be noticed as an example of this difficulty. The organic and volatile matter estimated from difference is 91.412 of which only 22.298 grains is actually organic matter.

The soap test was then employed to determine the total hardness, permanent hardness, and by difference, the removable hardness. Also the sulphuric acid, lime and magnesium. This test gave satisfactory results on all of the specimens but one. In No. 11 the permanent hardness was greater than the total hardness; that is, the water was harder after boiling than it was before. The tests were repeated until no doubt could be entertained of the fact. I cannot explain this anomalous result. For SO_3 the soap test appears to give very satisfactory results, but for lime and magnesia the process as described are highly empirical and give results of but little or no value except when applied to water containing those bases as carbonates, and which at the same time is free from alkaline sulphates and chlorides. Waters containing the last named salts are rendered harder by them. If then the total hardness is used as a basis for the estimation of the lime, it is obvious on a moment's reflection, that if, as advised by Parke, the total hardness in tenths of a cubic centimeter be divided by four and a drop of ammonium oxalate solution added for every four degrees of hardness in a carbonated water, the same rule applied to a water containing alkaline chlorides or sulphates would cause an addition of anexcess of the precipitant which adds to the hardness. For this reason I found it impossible to estimate the lime by the soap solution in Nos. 7, 9, 11 and 12. I have but little confidence in the results given for the other numbers. The magnesia was still worse for the entire hardness produced by alkaline chlorides or sulphates is included in the magnesia by Parke's method, as neither chlorine or sulphuric acid in combination with the alkalies is precipitated either by boiling or by ammonium oxalate. I have therefore omitted the estimates of magnesia in all cases as in those in which the determination was made, I had no reason to believe the figures reliable. The chlorine was estimated by a standard solution of silver nitrate, verified in No. 13 by precipitation and weighing; in which case the results corresponded to one one-hundredth of a grain.

We have reliable data therefore for comparing the waters in reference to the amount of mineral matter in solution, the total and permanent hardness, the sulphuric acid and the chlorine.

A comparison of the different specimens shows a range of amounts of mineral matter in solution varying from 6.304 grains to 390.158 grains in a gallon.

Numbers 13 and 8 are properly termed mineral waters. Numbers 1, 2, 3, 10, 11 and 12 are very hard well and spring waters; numbers 6, 7, and 9 are ordinary hard waters, while numbers 4 and 5 are quite pure river waters when we consider that they flow from and over sedimentary formations.

Numbers 4 and 5 are quite free from sulphates and chlorides. It will be further observed in reference to the remainder that with the exception of number 13 the sulphates are not extremely large, while again excepting number 13 the chlorides are very large, especially in numbers 7, 8, 10, 11 and 12. These results are unexpected, and I am especially surprised to obtain unmistakable evidence that the water of the Bois des Sioux river is purer than that of the Otter Tail—in fact is the purest water in the valley. A remarkable difference is also observed between the water of these rivers and that of the well at Conelley's. The mineral matter has increased about four fold, the chlorine seven fold, and the sulphuric acid three fold. These facts imply that the well water cannot be simply the river water, filtered through the gravel of the river bank.

So far as these results bear upon the subject of our inquiry they show that the waters of the Red River Valley do not contain large amounts of sulphuric acid, but that they are heavily charged with chlorides, probably largely combined with lime and magnesia. As a consequence they produce very hygroscopic residues when evaporated, and the accurate determination of the total solid residue or mineral constituents becomes extremely difficult if not impossible. An examination of the table shows that in every specimen in which the chlorine is large the organic and volatile matter is also large. This is not on account of an excess of organic matter but because the latter item is estimated by loss, and the loss consists of water retained at 130 deg. C., and also of a part of the chlorine from the decomposed magnesium chloride.

I cannot venture an opinion based upon these results, as to the cause of the water of many wells becoming fœtid on standing, or when the well is used but little or not at all. Number 11, is a colorless, odorless water, used by the entire population of Glyndon. Number 12. is from a well but a few rods distant from No. 11. It is of a yellowish color, contains a black sediment, and is heavily charged with sulphuretted hydrogen gas. Examination has thus far proved them to be of the same general character, with no difference in any respect that can be regarded as important. If the solution of this question is deemed desirable, I should recommend the selection of a number of typical specimens and their complete analysis, for organic, as well as mineral constituents. I should also advise a microscopic examination by an expert if possible. I would recommend as preliminary to the selection of these specimens, a further exploration of the valley, and an examination by the soap test, and for chlorine, of a large number of waters, particularly those from springs, and if possible from wells that are free from exposure to filtration of surface drainage, and filth filtered from sink drains, barn yards, and the streets of towns.

As an illustration of the difficulties attending the drawing of any conclusions from the results thus far obtained, Number 9 may be mentioned. The permanent hardness is less than in any other specimen, indicating an absence of magnesium, sulphate and chloride. There was no calcium and magnesium chloride in the residue. Therefore, no water was retained at 130 deg. C. The 9.147 grains of organic and volatile matter is doubtless organic matter, and is a comparatively large quantity. The source of this organic matter it is impossible to determine, unless its character be ascertained. The water smelled as if contaminated with sewage from a sink, and may contain the soakage from the Brewery in which it is situated, or the organic matter may be derived from the clay. The bad well at Glyndon is near a barn, and the surface around it was covered with kitchen slops when the specimen was obtained. The residue from the water had a decided odor of urine. The question whether these organic contaminations are derived from the subsoil or from surface infiltration, becomes therefore a fundamental consideration, with reference to the prevention of cure of the undoubted bad qualities of most of the water examined. The amount of calcium bi-carbonate is not large in these specimens of water, while chlorides are abundant. It would not therefore be advisable to recommend the use of Clark's lime process.

An examination showed the clay to contain a large amount of organic matter. No other result could have been expected. Respectfully submitted,

S. F. PECKHAM,
State Chemist.

Number.	Total Mineral Matter.	Organic and Volatile.	Total Residue at 130° C.	Removable Hardness.	Permanent Hardness.	Total Hardness.	Chlorine.	Sulphuric Acid ($S O^3$).	Lime (Ca O.)	REMARKS.
1	53.119	5.078	58.197	2.081	8.026	10.507	13.075	2.568	2.098	Colorless, odorless, had deposited iron.
2	62.458	12.316	74.764	10.216	15.468	25.684	10.623	4.202	7.647	" " " "
3	55.454	12.841	68.295	8.756	11.960	20.722	No estimate.	5.370	6.864	Turbid, odor of putrid brine ; iron.
4	8.279	4.142	12.421	.584	5.545	6.129	1.400	1.467	2.000	Colorless, odorless, had deposited iron.
5	6.304	5.137	11.441	3.210	4.086	7 296	1.400	.700	2.654	Yellowish, odorless.
6	26.617	3.210	29.827	3.210	7.880	11.090	10.098	3.502	2.980	Colorless, odorless.
7	33.156	11.440	44.596	0.000	8.436	8.436	28.077	0.000	No estimate.	Odor and taste swampy, yellowish.
8	196.656	34.556	231.212	43.779	20.430	64.209	42.728	(?)	6.864	Musty, dirty yellow, much iron.
9	31.988	9.147	41.135	12.550	1.167	13.717	9 740	2.334	No estimate.	Colorless, odor like a sink drain, deposit like clay,
10	48.967	43.662	93.629	9.340	6.712	16.052	156.204	2.334	2.918	Colorless, odor marshy, deposit like clay.
11	41.736	17.628	59.364	(?)	20.038	13.133	46.289	1.467	No estimate.	Colorless, odorless, deposit of iron.
12	49.675	20.488	70.163	3.502	5.837	9.339	56.096	2.200	No estimate.	Yellow, odor of $H_2 S$, deposit black.
13	390.158	90.412	481.570	No estimate.	No estimate.	No estimate.	1.061	174.241	45.658	Residue on evaporation had the appearance and odor of a urine residue.

	Total Mineral Matter.	Water, etc. retained at 130° C.	Organic Matter.	Total Residue at 130° C.	Residue in Ba S O_4.	Insoluble, H Cl Si O_2.	$Fe^2 O^3$ and $Al_2 O_3$.	S O_3.	Cl.	$Fe_2 O_3$, $Al_2 O^3$ and $Fe_2 P^2 O_3$.	Ca O.	Mg O.
13	390.158	69.114	22.298	481.570	51.542	4.412	3.035	174.241	1.061	10.723	45.658	29.443

Conclusions.

The foregoing ascertained facts will warrant the statement of sundry conclusions which may be given briefly as follows: They pertain to the solution of the question—whence come the foul odors of the wells in the Red River region?

1. The drift clay affords a strongly alkaline water.
2. The lacustrine clay affords a slightly or non-alkaline water.
3. There is generally a water-bearing stratum of sand, or of gravel and sand, between the lacustrine and drift clays, which affords a good water in nearly all cases.
4. The drift clay comes largely from the disruption of the marine Cretaceous clays, and that accounts for its greater alkaline qualities—while,
5. The lacustrine clay is a deposit of superficial fresh waters.
6. There is a water-bearing stratum in or near the bottom of the drift clay which is under considerable hydrostatic pressure, and water from it rises nearly or quite to the natural surface.
7. Nearly all of the wells in the Red River Valley are curbed with wood of some sort, generally pine.
8. This wood undergoes rapid changes due to the chemical reactions between organic acids and alkaline waters, as above described under natural circumstances.
9. This source of foul odors is abundantly sufficient to account for all the phenomena.
10. The organic matters cannot come from the lacustrine clay, because the odors are equally prevalent all over the western part of the state where no lacustrine clay is found.
11. These organic matters cannot come from the drift clay, because they are found in wells that do not enter the drift clay.
12. Any organic matter in either of these clays would have long since passed through the stage of decomposition necessary for the production of such gases, and entered into a carbonaceous and fixed condition.
13. The assumed cause of these odors, whatever it be, must be one that is coextensive with the effects—hence,
14. They cannot come from surface indrainage, since they occur in wells where that is impossible.
15. They cannot come from sewerage or other artificial underground sources, because they occur generally in wells where such contamination is impossible.
16. This fermentation of the sap and pitch of the pine sometimes has the effect of giving the less alkaline waters of the valley, in its incipient stage, a taste as of kerosene, and the appearance of small globules and films of oily consistency and spacific gravity floating on the surface.
17. The effect of this change may be obviated, or mitigated, by copious use of the wells; and it may be wholly avoided by using earthen or iron pipes, and discarding the wooden curbing.
18. Shallow, open wells, dug in the surface of the prairie and having alkaline water, may become offensive in the summer, though without curbing, by the decay of fine organic particles blown into them, or washed into them, from the rank vegetation of the prairie turf.

In the progress of this investigation the writer became impressed with the sufficiency of pine wood to produce such odors, by a simple test experiment; viz:

Two quart glass jars were filled with good well-water, not alkaline, taken from the same well. Into one was put a quantity of pine chips, but into the other nothing was placed. They were exposed to the atmosphere of the same room, the glass stoppers being inverted and loosely placed over the wide mouths. While the jar with nothing but clean water remained clear and inodorous during the continuance of the trial, and indefinitely thereafter, the other went through the changes indicated by the following.

Records.

Dec. 4. Place a quantity of seasoned pine sticks in a wide-mouthed glass jar in common well water. The jar stands on a table in a warmed room, loosely covered by the inverted glass stopper. The sticks all float.

Dec. 5. A portion of the sticks have sunk to the bottom of the jar, and small bubbles of some gas adhere to some of them.

Dec. 6. Nearly one half of the sticks have settled to the bottom. The jar when uncovered smells strongly of fresh pine. Gas bubbles are more numerous.

Dec. 7. There is no noteworthy change.

Dec. 8. There is no noteworthy change, except perhaps a stronger pine odor.

Dec. 9. The pine smell is very strong, and less fresh.

Dec. 14. A thin scum floats on the surface. There is an odor of sourness.

Dec. 19. The floating scum begins to settle, some of it swimming in the water.

Dec. 21. The scum on the surface adheres to the glass, and looks gummy. The odor is less sour, and somewhat offensive.

Dec. 25. The odor is offensive, and there is a gelatinous gum adherent on the glass, and along the water level.

Dec. 28. The odor is strongly offensive.

Dec. 31. The odor is very offensive and foul, as from organic decay. There is a white, gelatinous or gummy scum, as of fungoid growth, adherent on the glass about the water level, and floating in flocks on the surface. It sometimes appears, especially on disturbance of the jar, in globular masses of ⅓ to ¼ inch in diameter.

Jan. 1. The microscope reveals great numbers of organic germs, which are oval in shape and appear to be of the *Ciliata*.

Jan. 10. A jelly-like fungus, about a quarter of an inch thick, floats about in the water and on the surface. The odor is very offensive.

May 1. There is a swimming fungus which tends to settle to the bottom of the jar. The water is slightly turbid, and yellowish-red. It has a musty smell, and also is plainly acidulated. The microscopic animals are equally abundant, and of various forms.

In the presence of such a source of organic decay and contamination found in nearly every well in the whole region, it is evidently unnecessary, and even absurd, to search for any other.

These considerations bring up the whole question of the prevalence of typhoid fever as an endemic disease in western Minnesota and Iowa, but it is not germane to this report to enter on its discussion. Nothing more can be done here than to call the attention of those interested in the sanitary condition of the state to these facts, and to suggest that possibly the climate has less to do with such diseases than has been imagined, and that probably their causes lie nearer, and within the grasp of ordinary preventive measures. The effect of the water is not always an immediate typhoid fever, but an aggravated diarrhœa, and then dysentery, which lead finally to typhoid fever. This is the testimony of Dr. J. C. Rosser, of Brainerd, and also the experience and observation of many others. Sometimes the fever assumes a local name. At Bismark it is known as the "Montana fever." In Moorhead it is known as the "Red river fever," but they seem to be all essentially typhoid fever.

III.

RECONNOISANCES.

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1. Into Wright County.

Information having been received from Hon. William Pfænder of the existence of some evidences of coal in Wright county, an examination was made of the designated localities. On Sec. 33 T. 119 N., R. 25 W., land of John Marth and Fred Wanderzee, along the north branch of Crow river, pieces of Cretaceous lignite have been found in considerable quantities; also, along a creek, Sec. 25 T. 119 N., R. 26 W., on land of Joseph Plant. These are all float pieces, exactly similar to what have been found in numerous other places, though perhaps more abundant. An examination was made in company with Mr. John Marth, of Delano. The banks of the streams are composed entirely of drift, and largely of blue hardpan. The lignite was seen in the bed of the creek, having been most observed at or near fording places, where it was most likely to be brought to the surface and seen by passing travelers. At no point could any Cretaceous beds be seen *in situ*. Along the stream are numerous pieces of slate, or fissile shale, likewise derived from the Cretaceous, though here immediately from the hardpan drift. It is possible that Cretaceous beds would be struck below the drift, in sinking a shaft.

2. In Rice Connty.

In company with Prof. L. B. Sperry, a number of localities of rock-outcrop were visited in Rice county, for the purpose of determining the main characters and the continuity of the Trenton and Shakopee. The details of the geology of this county are given in the report of Prof. Sperry, and it would be simply repetition to give them here. The most interesting observation made, was the discovery of a carbonaceous layer in the Lower Trenton, exposed along Prairie creek, which without previous drying will ignite from a common match, and burn with a flame.

3. *In Goodhue County.*

The examinations made in Goodhue county were in company with Hon. H. B. Wilson and Dr. W. W. Sweny, and consisted of a visit to the quarries at Wanamingo, Zumbrota and Red Wing, and the collection of two boxes of specimens.

The eastern part of the county is rolling, with frequent rock exposure in the brows of the hills, but the chief covering of the rocks is the loose loam with a thickness of 50 to 75 feet, sufficient to make the ascents generally tillable, while in the western portion the drift prevails so as not only to fill up the old rock-canons, but to convert the surface into an undulating prairie. The drift gradually thins out eastward under the loam. It seems to have suffered extensive denudation by aqueous forces, so that what is left of it visible under the loam is coarse and gravely or stony. A very large boulder of red or flesh-colored granite projects above the surface of the loam on N. W. ¼ of section 29, in Belle Creek. It lies on high land, and is conspicuous from a distance. It rises about nine feet above the ground, and has a circumference of 26 paces. It belongs, of course, to the old drift epoch, and not to the last, as it is embraced in and partly covered by the loam, the loam not having covered generally the newer drift in that part of the state. It is evident that the denudation to which the old drift-surface was subjected, produced the material for fine clays which gathered in quiet spots, since under the loam, in old canon-valleys, and also in some places less protected, there are extensive laminated clays. The Red Wing pottery-clay comes from below the loam, on Sec. 3, Goodhue, Goodhue county, and has a light gray, bluish color. The whole excavation was unfortunately covered by water, and nothing could be learned of the relation it bears to the drift or the loam. The Terra Cotta clay, of Red Wing, is the blue interior of the terrace that accompanies Hay Creek. It is in horizontal laminations, and upwardly passes gradually into the loam. Between the two drift periods it seems that the country had a forest covering, since in Goodhue county, no less than in Fillmore and Olmsted, there are abundant remains of timber and of the old soils. On Sec. 2, Wanamingo, on the high prairie, land of Wm. Boulett, a log of what appeared to be hemlock, or coarse pine, was found in digging a well, at the depth of 26 feet below the surface. This was embraced in a "bluish-blackish" clay, apparently a soil, and was five or six inches in diameter. It was covered with a hard, gravely, yellowish clay and by the loam that covers that part of the county. Also on Sec. 5, Belvidere, land of John Holtz, in the valley of the creek, was found wood twenty feet under the surface, in the gravely blue clay, or under it. On Sec. 24, Chester, Wabasha county, a log a foot in diameter was found in digging a well, upon the high prairie, said to be about twenty feet below the surface. This log was well preserved and could be chopped. It lay on the ground near the well for some years.

At Wanamingo the Lower Trenton is quarried in a low bench along the Zumbro. This bench rises higher and higher above the Zumbro in descending the stream, and finally the St. Peter sand rock appears, and then the Shakopee limestone, which, at Zumbrota, supports the south end of the bridge over the river, rising about 25 feet above low water. The stone for the abutments and foundation for the Forest Mills was taken out of this rock near the mills; but the stone for the bridge at Zumbrota came from the Trenton in higher land near Zumbrota. The Forest Mills are about two miles below Zumbrota. The Shakopee here causes a terrace-flat on which is situated Zumbrota village, but there is a covering of drift-gravel and loam.

A few aneroids were taken at Red Wing, and a general section was obtained of Barn Bluff. The top of the bluff is covered with loam, which also hides the rocks from sight down a sloping descent of about 70 feet. If this be regarded as containing limestone the thickness of the limestone will amount to 120 feet. From the top of this there may have been destroyed several feet of limerock. The general section then consists as follows, in descending order:

1. Slope and limerock..........	120 feet.
2. Sand and green-sand, and limerock,....	40 feet.
3. Massive sand, the upper portion being white, the lower portion yellow. From this the glass sand is taken.........	50 feet.
4. Sand and green-sand, with cement of lime and magnesia, with distinctly aluminous portions. To the flood plain......................................	80 feet.

Barn and Soren bluffs dip toward the east a few degrees. There are extensive quarries in these bluffs, that furnish a fine building material. The stone now being used in the bridge over the east channel of the Mississippi at Minneapolis is from the quarries of Mr. Carlson in these bluffs.

4. *On the Northern Pacific Railroad.*

The details of this reconnoisance, so far as they relate to the water supply for domestic uses, are given in the chapter devoted to *Water-supply of the Red river Valley.* The only rock exposure along the line of the Northern Pacific R. R. after leaving the neighborhood of the Junction with the St. Paul and Duluth R. R., within the State, occurs in the vicinity of Motley. This is a range of granite, about four miles north of the station, on sections 21, 22, 27 and 28, extending north and south. It widens out toward the north before disappearing under the drift. Its extent is about a ¼ mile across from north to south. The country round about for miles is nearly level, and covered with Pinus Banksiana, *Lam.* It escaped the observation of the land surveyors of the N. P. Company, and the land was entered and described as having "no stone." There are here hills and ridges that rise fifty or seventy feet above the surrounding country, and in some of them the rock is bare. It cannot be said with certainty that this rock exists in all these hills and ridges, but it probably does. There are but few spots where any drift boulders can be seen, the country—even these hills—being covered with sand or sandy loam. The surface of the rock is old. It does not show recent glaciation, the appearance it presents being rather that that would be attributed to aqueous forces. The surface is, in general coutour, *moutonne-ed*, but not so markedly as the knobs and hills of Marquette and Duluth. Since this glaciation it is evident that water has covered this rock for a long period—water probably which spread the fine sand over so wide a belt, extending almost uninterruptedly from near Thompson to this place.

The rock rises in undulating sheeps-backs, and in the intervals is covered with sand and turf. It consists, taken all together, of at least three different qualities, viz: First, a gray syenite (?) which has a greenish mineral like serpentine and also both white and flesh colored pieces of feldspar, rather fine grained. Second, a dark, diorytic, trappean rock that occurs in apparent, wide dykes in the granite. This varies from a petrosilex, (or what may be taken provisionally for that rock) to a real dioryte. Third, a serpentinous granite, i. e. a granite (with white feldspar) that contains a green mineral undistinguishable from the green mineral of No. 1, with evident lumps of mica. These three kinds may not be the only variations that the rock will on quarrying exhibit, but they are the only noteworthy ones observed. They are all rather fine-grained. The green mineral of No. 1, is sometimes more abundant in streaks or veins, even two inches wide, than throughout the rock, giving the rock a striped aspect, often two or three thin veins coming within a foot. This rock was discovered and purchased of the N. P. R. R. by Mr. C. H. Alsop, who is beginning to open it for sale. Being in the midst of a country destitute of known rock, especially of granite, this locality has much importance. It will furnish a building material of the most durable kind, and possessing all the excellencies of the granite of St. Cloud or Sauk Rapids.

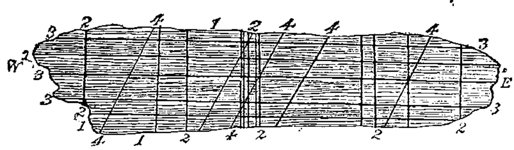
From Brainerd to Motley the country is about the same as at Brainerd, i. e., a sandy plain. The timber consists largely of Bank's pine. Wadena and Perham are on prairie openings. At the latter place the subsoil is a gravel-and-sand to the depth of at least 15 or 20 feet, as revealed by wells that get good water at that depth. This gravel-and-sand is like that on which Minneapolis stands, but is not overlain by so distinct a loess loam. The loam here is only soil-deep, and also contains occasional little pebbles, the same as found in the gravel below, showing that the loam is only a soil formed from the sand and gravel of the subsoil. This subsoil of gravel-and-sand continues westwardly, through and beyond the prairie on which Perham stands, and into a sparsely timbered and undulating country, even beyond Frazzee City. It is noticeably *free from boulders*, and consists only of gravel and sand. On approaching the Leaf Hills the gravel and sand becomes gradually coarser, with occasional stones, the general surface also becoming more broken. Further on the gray hard-pan, very stony, comes in, at first gradually as if the gravel and sand were horizontally merged into it by the accession of clay and larger stones, but finally so as to comprise the mass of drift, as seen in the cuts by the grade of the road. The hills are composed of this hardpan. At Detroit the surface is undulating and somewhat rolling, but mostly a prairie, being fairly on the west side of the Leaf Hills. There is a little timber west of Detroit, but the prairie sets in within a couple of miles, and continues to Moorhead. The subsoil at Detroit is the same as at Perham, a gravel and sand, the surface-soil being a loam, derived locally from the subsoil by disintegration and the action of vegetation. The roads are always dry; the wells go into gravel for water at the depth of 25 or 30 feet, the supply being good—limy or chalybeate—and copious.

Above Brainerd about five miles, are the French Rapids, in the Mississippi river. Their immediate cause is a quantity of drift boulders, which lie mostly along the left shore, though they are also of course throughout the bed of the channel; but their original cause is probably the nearer approach of the bed-rock toward the surface of the drift. A short distance above these rapids, on the left bank is a high drift bluff composed largely of clay, but containing numerous stones and boulders. Below the rapids the river runs along the left side of an alluvial, timbered island. The fall in the rapids is about three feet. No bed-rock can be seen. There are a few boulders also along the right bank just above the head of the rapids. The bottoms are covered with deciduous trees, but the upland mainly with Banks' pine, with some white and Norway pine.

East of Brainerd the country is mainly one of plains, which are superficially sandy, but they must be closely underlain by a clay deposit, since they often become wet, when large swamps are caused by the contained water. There are also numerous ridges of hardpan-clay soil and subsoil, in which a different outward appearance is very marked. The trees become larger, and consist of a greater proportion of deciduous species, while the Banks' pine entirely or almost wholly disappears, and the Norway and white pines prevail. Toward the Junction the hardpan clay comes in in full force and continues to Duluth, except when overlain by the red laminated lacustrine clay of Lake Superior.

At the Northern Pacific Junction, prominent and bare ridges of slate, four to six in number, rise about 25 to 40 feet. They run nearly E. & W., or by compass north 80 degrees east, varying to north 75 degrees east. The slaty cleavage runs nearly parallel with the direction of the ridges, or north 85 degrees east. In approaching from the west, along the N. P. R. R. this slate becomes perceptible a short distance before reaching Komoko; and, by the topography and changed drift, rock is evinced for several miles even before reaching that place. These ridges run through Komoko and the N. P. Junction, and at least to Thompson, where they have been wrought, the slate quarries being about two miles from the railroad in Sec. 29, T. 49 N., R. 16 W. They are not continuous, nor uniform in height nor in length. They rise, and sink again below the surface, with an irregular alternation. Sometimes a section across the range would show only three or four series and sometimes there might be six. Often the intervals in one series are opposite the ridges in the adjoining one. The rock itself varies from an argillyte suitable for roofing, to a very dark, or gray quartzyte that shows less slaty cleavage, yet must probably be taken as a part of the same slate group. The rock of this latter kind seems to be found in some of the ridges exclusively, while the argillyte prevails in others. Outwardly they have about the same appearance, as they lie in long parallel, undulating ridges, and perhaps they should not be so prominently distinguished as this description implies. These ridges are moutone-ed, but there are no scratches or other marks showing the direction of any glacial action. They have three systems of jointage planes crossing each other at various angles, so that the rock itself is cut into large angular blocks to great depths, which not only facilitates the quarrying of the slate, but the natural disintegration of the ridges by frost. The adjoined sketch shows a ground plat of one of the ridges, with the different systems of joints:

FIG. 2.



Ground plat of a slate ridge at Junction.

Explanation of Figure 2.

1. 1. Slaty cleavage, nearly perpendicular, runs north, 85° east.

2. 2. Joints that cut the slaty cleavage at right angles, but slope west at an angle of about ten degrees from a perpendicular. They are sometimes so numerous as to number four or five in the interval of a foot.

3. 3. Joints (or bedding) which run parallel with the ridges, but slope south at an angle of about 45° with the horizon. The southern slopes of the ridges are formed by the splitting off of the layers, while the northern slopes are apparently caused by the breaking off, by an irregular and shifting fracture of the same layers, and have an angle about the same as the southern slopes, but in the opposite direction.

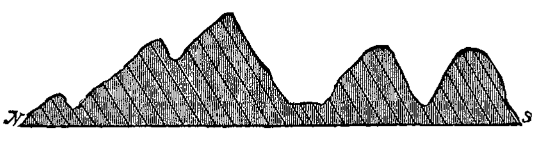
4. 4. Less distinct oblique joints that do not seem to be as numerous as the foregoing, but which, on the quarrying of the rock, are seen to penetrate to as great depth. These aid in causing the superficial parting of the rock into rhomboidal and angular masses. They slope N. W. at an angle of about 25° from a perpendicular.

The horizontal extent east and west is about six rods.

Figure 3 is a perpendicular section running north and south across these ridges, showing the direction of the slaty cleavage and of joints 3. 3. of Fig. 2.

This slate appears to be the same as seen at Little Falls, on the Mississippi below Brainerd, but it here shows none of the concretionary hornblend, or dioryte rock, and, taken all together, is somewhat finer grained, not showing an evidently micaceous composition.

FIG. 3.



Section across the slate ranges at Junction.

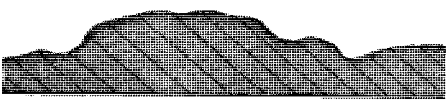
IV.

THE GEOLOGY OF MORRISON COUNTY.

This reconnoissance was made in company with Mr. N. Herrick, of Minneapolis. The first observations were made at Pike Rapids, which are at the mouth of Swan river, but are in the Mississippi. They are so named from Lieut. Z. M. Pike who built a stockade and wintered with his men here in 1805–6. They are caused by a mica schist rock which rises in some spots about six feet above the water at low stage, but lies mainly in the river channel. The only outcrop on the shore seen being in the left bank. The schist is filled with small crystals of garnet and coarse crystals of staurolite. Besides these clumps of schist rock rising in the channel of the river, there is an abundance of boulders of all kinds, both in the river and on the shore, the banks rising about 30 feet and consisting of coarse material. The rock itself seems to dip, at least it has a laminated structure which dips, toward the northwest at an angle of about 45 deg.

At Little Falls the rock that occurs in the river is a roofing slate similar to that at Thomson, but varies from a mica schist to an argillyte, with some veins of white opaque quartz. The rock in some places also varies to a massive, compact hard rock with sharp jointage angles, whch, when broken, has nearly the color and texture of the staurolite crystals, if fractured. found in the rock at Pike Rapids, but seems to be more nearly a dark quartzyte. Besides these variations there are nearly continuous layers of more or less lenticular and concretionary lumps or nodules, sometimes six or eight inches thick, of a rock very firm and dark-colored, but which on weathering becomes superficially lighter-colored and shows needles and spangles of dark-green amphibole. The matrix in which these crystals lie is not well characterized, but is quartzytic and perhaps also feldspathic, but is dark-colored, so that on a fresh fracture the amphibole crystals are hardly observable. They appear on the weathering of the rock. By far the greater part of the whole is a micaceous argillyte, with slaty cleavage nearly perpendicular, or sloping a very little toward the N. W. (N. 18 deg. W.), the strike being N. 18 deg. E. There is also a system of joints that gives the rock, viewed across the river, the appearance of being conspicuously stratified, with a dip up the river of about 45 deg. from the horizon. The slatiness, which is nearly perpendicular, is somewhat injured, at least superficially, by the frequency of joints, of which there are at least two systems intersecting each other at a small angle, thus cutting the slates into rhomboidal masses, as they weather to pieces. The following diagram (Figure 4) is designed to show the relation between the slates and the three systems of joints mentioned. The general exposure is an irregular expanse in the river channel, and bottom land, but does not rise in ridges or knobs, though the occurrence of a dyke of dark trap, and the massive quartzytic rock, seem to have been the primary cause of this protrusion upward of the underlying formation which is generally more deeply buried under the drift. This is known to extend under Little Falls village, being encountered in wells and cellars.

FIG. 4.

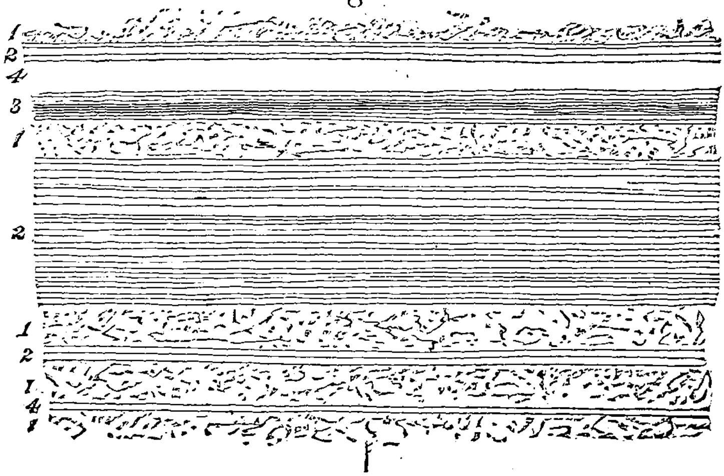


Jointage of the slate at Little Falls.

A little distance further down the river, yet scarcely outside the limits of the village, rock is exposed on "the point," and consists, in general, of a hard, dark-colored dioryte, containing mainly amphibole in coarse crystals, and a little feldspar (labradorite?). The outward characters of this rock are the same as the concretionary lumps that exist in the slate already described. It is here simply in larger area and bulk. It is parted by joints that cause it to fall to pieces in slabs and cuboidal masses. This *may be* here in the form of a dyke, but its relation to the slate cannot be seen. The point which is formed by it is considerably higher than the bottom land on either side, but falls away somewhat on receding from the river, the rock itself becoming lost to view in the swampy bottoms, or involved with the drift of the river-bluffs. On long-weathered surfaces, under the action of the water, there is a ridged and furrowed form that shows the same direction and trend as the slatiness of the slate, i. e. N. 18 deg. E. These ridges are about ¼ inch apart, and about ⅛ or

¼ inch high, separated by intervening furrows. This surface configuration is apparently due to the alternate arrangement of the mineral contents, and perhaps has its origin in a metamorphosed condition of the slate itself, or of the sedimentary rocks from which they both may have been derived. Thus this could not be of the nature of an igneous dyke, but a metamorphic variation due to the complex nature of the original sediments. This view is strengthened by the occurrence of a similar diorytic rock, in concretionary masses, in the slate itself, running in more or less regular layers or lines. This alternation of mineral contents does not pervade the whole of rock exposed on "the point," but it is a conspicuous feature in some places. The ridges are composed of the lighter colored minerals, and the furrows of the amphibole. The adjoining figure (Fig. 5.) illustrates the alternation of these ridges and furrows.

Fig. 5



Arrangement of Mineral Contents at Little Falls.

Explanation of Figure 5.

1. Bands of dioryte.
2. Alternating bands of amphibole and feldspar.
3. Furrow mainly occupied by a band of amphibole.
4. Feldspar band.

Opposite the village of Little Falls a trap dyke of basic doleryte, apparently about 10 feet wide, appears in the slate, going diagonally across the slate; and on the south side of the dyke, in the lee of its protection against the current of the river, as well as against, possibly, the ice of the ice-period, the slate (or schist) is decomposed to the depth of four or five feet at least, making a greenish-blue clay, or incipient kaolin.

The slate at Little Rapids is visible, along one or both sides of the river, as far up as the ferry, perhaps three-quarters of a mile above the village.

On the N. E. ¼ Sec. 13, (R. R. land), Little Falls town, on the west side of the river, is an area of dark granite, rising in smooth knolls a few feet above the surrounding country, which is flat and rather wet, though sandy, and in fact is an eastward continuation of the flat of the west bank of the river at Little Falls. This rock is not in all places a true granite, but varies to a dark, apparently trappean rock, which is an amygdaloidal melaphyre*, containing, however, a light-green mineral like serpentine. There are also variations to a non-amygdaloidal melaphyre with scattering mica-scales.

At the mouth of the Little Elk river, two and a half miles above Little Falls, the slate seen at Little Falls again appears, but here the direction of the slatiness is N. 30 deg. or 35 deg. instead 18 deg. east. The creek runs across it and cuts into it. The dam is made between the rock bluffs on either side. The slate is known to extend up the Little Elk only about half a mile.

N. E. ¼ section 26, Belle Prairie. Here is an outcrop of granite. It rises not more than eight or ten feet above the general surface, which is nearly level. It is rounded over but is not striated. Its color is sometimes pink and sometimes gray. It is rather massive than schistose. Its area probably extends over on the next section north. Similar rock occurs again about two and a half miles northeast of this place on section 18, in the next town east.

PRIMITIVE MAN AT LITTLE FALLS.

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(1). The Stone Cutters.

During the examination of Pike Rapids some search was made for Pike's winter stockade. Near the principal exposure of the bed-rock, along the east bank, abreast of a small island scantly turfed over, there is a blind excavation in the river-bank which consists of loose

* This term is used here in the indefinite sense preferred by Bernhard Von Cotta.

sand and fine gravel, that has the appearance of having been artificial, but no old timbers could be found in the vicinity. Paris Roy, a half-breed living at Little Falls, says he remembers hearing his uncle, a trader for the American Fur Company, named Charles La Rose, stationed seven or eight miles above Little Falls, at that time, relate the fact of Pike's stopping here and describe the place as on the east bank, and below the rapids. This excavation is really below the main rapids, though there is half a mile of rapid water below it, caused by boulders, without exposure of the bed-rock.

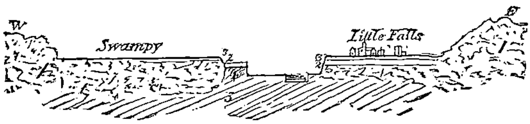
About this excavation, which may or may not have been the site of Pike's stockade, are pieces of chipped white quartz, which from their sharpness, and their color, indicate an artificial origin, and attract the eye of the visitor. It was only after a handful had been gathered, that at last an imperfect arrow-head was found. These chips, at this point, were found only over a small area, indeed they were not looked for at other points up or down the river, nor at any depth below the surface. This quartz, which is white and opaque, was evidently taken from some vein in the slate in this neighborhood, for the slate at Little Falls has several veins of that kind of quartz.

Subsequently however, these chips were found to extend over a larger area, and to be incorporated with the materials of the river banks. Further examination at Little Falls disclosed this interesting discovery. They are found, not only on the surface of the flat on which Little Falls village stands, especially near the river, but on excavating the bank near the river, making a perpendicular section, they are found to extend downward three or four feet into the sand and gravel. A person in digging half an hour might find twenty-five or thirty. The material in which they occur is a homogeneous sand, passing downward gradually into a coarse sand and finally into a gravel. This flat along the river on the margin of which they are found, is about twenty-seven feet above the river, and is now never covered by it. The bank itself may be divided into three parts, as follows, in descending order:

1. Loam sand, gravelly below.
2. Gravel, becoming stony below.
3. Hardpan-drift, containing boulders.

The plain on which Little Falls stands, is about a mile wide, and extends along the river, as an abandoned ancient flood-plain, southward, and becomes that on which East Minneapolis is situated. Toward the south its average width remains about the same as at Little Falls—perhaps becomes less—but toward the north it increases in width, and at the same time rises above the river, and finally comes apparently to constitute the entire country about. Brainerd (with the sandy country east of it) is on such a plain; towards the west a sandy plain of the same nature, and the same level extends much further, though, opposite Little Falls, it is occupied to a large extent with wet land and often by tamarack swamps. On either side of the river, outside of this plain, is a line of drift bluffs which have a rolling coutour and rise from 50 to to 75 feet higher, constituting a greatly different character of country, and occupying the general level for an indefinite distance east and west from the river. Northward from Little Falls, while the included plain becomes wider, and covered with a coarser sand, these bluffs gradually become lower. It seems as if the plain slowly rises to the level of these drift-bluffs, and the bluffs themselves then are lost to view, or are so broken, and involved with other drift knolls and ridges, that they seem to have no relation to the river itself. In traveling by the new railroad, lately constructed between Brainerd and St. Cloud, this change is observable. The road itself, at least between Little Falls and Brainerd, runs throughout on this plain. In reverse order the depth of the river below this plain increases in going northward. At East Minneapolis it is from 25 to 30 feet above low water; at Shingle creek it is about 37 feet; at Champlin it is 43 feet; at Dayton 45 feet; at St. Cloud 58 feet; at Brainerd about 60 feet. No measurements have been taken above Brainerd. Along the river at a lower level is another flat, or bottom-land, which is the present flood-plain. The hardpan drift which prevails in the bluffs on the east side of the river, and which underlies the sandy plain above described, seems to be of the old drift epoch (see report on Hennepin county for 1876), and lies on the slate at the Falls. The adjoining diagram (Fig. 6) represents a section across the Missississippi valley at Little Falls:

FIG. 6.



Section across the Mississippi valley at Little Falls,

Explanation of Figure 6.

1. Hardpan drift, on the east side covered with a fine clayey loam.
2. Gravel and sand.
3. Sand, loamy above and gravelly below; 60 feet above the river at low water.
4. Trap dyke.
5. Slate rock.

The quartz chips occur in No. 3, and abundantly on the flat (somewhat lower than the average here) directly opposite Little Falls, in the neighborhood of the trap dyke. They extend up and down the river also an unknown distance. They were found at the mouth of the Little Elk, two and a half miles above Little Falls. The belt on the west side which seems to afford them is about 40 or 50 rods wide, but something less than ¼ mile on the east side. On the west side they appear in the soil when large trees tear it up.

These chips are all angular, some of them being as sharp as knives, and perfectly unwaterworn, and they occur in a waterworn deposit. They vary in thickness from that of paper, and the size of one's fingernail, to one and two inches across, of irregular, angular forms. Almost no other coarse material is found in the surface sand in which they are found; and whatever there is, is waterworn and rounded. The chips are generally without evidence of designed form, and nearly all the angular pieces are also destitute of all evidences of artificial shaping, so far as their forms are concerned. Only a few pieces were found that seemed to show the work of careful chipping, and they are not perfect. The most certainly chipped form found was taken at Little Elk river, but was of brown chert. Some of these chips are represented on Plate I.

The interest that centers in these chips, and which alone would warrant this extended account of them, involves the question of the age of man and his work in the Mississippi valley. When they were first observed they were taken to be of much later date than they seem to be, indeed they were associated with the builders of the mounds and ridges that are seen at Little Falls and many other places in Minnesota, attributable to a race known as the Mound-Builders, who preceded the present Indian races. But these mounds and ridges at Little Falls are built of the very sand, and are situated on the very same plain in which these chips occur. In other words, the Mound-Builders dwelt at Little Falls since the spreading of the material of the plain: hence they are post-glacial. The chipping race, if these chips are of human origin, preceded the spreading of the material of the plain, and must have been pre-glacial; since the plain was spread out by that flood-stage of the Mississippi river that existed during the prevalence of the ice period, or resulted from the dissolution of the glacial winter. The fortunate juxtaposition of these two classes of human remains enables us to establish this important general truth. The wonderful abundance of these chips indicates either an astonishing amount of work done, as if there had been a grand manufactory in the neighborhood, or an enormous lapse of time for its performance.

EXPLANATION OF PLATE.

(*See Page 56.*)

FIG. 1, *a*. Convex surface of a chert implement found at the mouth of Little Elk river, Morrison county, supposed to be a scraper.

FIG. 1, *b*. Profile view of same.

[NOTE.—This specimen is regarded a finished implement by F. W. Putnam, of the Peabody Museum.]

FIG. 2, *a*. Convex surface of a chert implement found at Little Falls.

FIG. 2, *b*. Profile view of the same. The figures do not perfectly represent the evidentally chipped edges.

FIG. 3, *a*. Broken arrow-head (?) of white quartz, found at Pike Rapids.

FIG. 3, *b*. Profile view of same.

FIG. 4, *a*. Scraper (?) of white quartz, from Little Falls.

FIG. 4, *b*. Profile view of same.

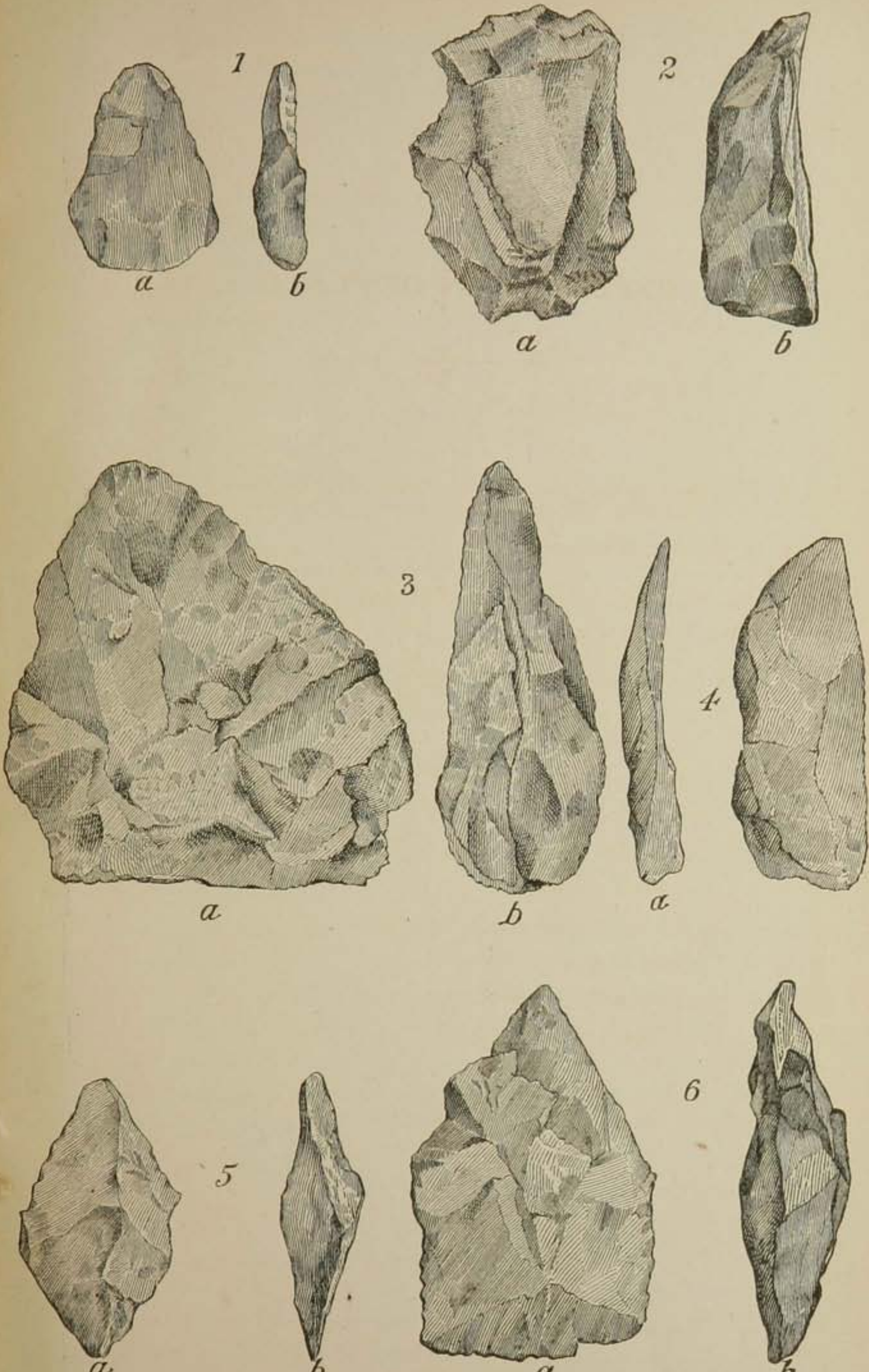
FIG. 5. *a*. Implement of white quartz, Little Falls.

FIG. 5, *b*. Profile of the same.

FIG. 6, *a*. Implement of white quartz, Little Falls.

FIG. 6, *b*. Profile of the same.

These figures are all of the natural size of the specimens.



C. L. Herrick Del.

Photo Eng. Co. N.Y.

There is one other source to which these chips can be referred. The veins of white quartz traversing the slate at Little Falls, from which these chips were originally derived, were observed in one instance (near the mouth of Little Elk river) to split into angular pieces similar to those taken from the surface sand of the plain, under the action of moisture and frost. This was seen at a point where the freshet water of Little Elk river had lately carried away the surface materials, laying bare a large area of the slate. The quartz of the vein, not having a mineral cleavage, yet had an irregular fracturing tendency which resulted in the disentegration of a considerable quantity of the vein. It is supposable that in some earlier history of the river, when it was large enough to cover the whole valley from the drift bluffs a mile east of Little Falls to the drift bluffs several miles west, this same disintegration under natural causes took place, and that by some means the fragments were distributed by the water of the river, perhaps by floating ice, over the flat on which they are found when it was the bottom of the river. This supposition meets with the following obstacles.

1. There is no point throughout the whole region round about where the slate conveying these quartz veins rises to the level of the surface of this plain so as to be within the range of transporting agencies, whether of the water of the river or of floating ice, but the quartz veins are from 40 to 50 feet lower than the flat on which the chips occur.

2. During the high stage of water that formed the chip-bearing terrace, that plain itself was intact from side to side, the present river channel which is cut down to the slate and the quartz veins, not having been excavated.

3. The chips seen at Little Elk river, resembling these supposed human remains, were in the bed of the river, and *under* the drift originally, even the unmodified glacier drift, while the transported chips are *over* the glacier drift and in a water-washed sand.

4. If these chips were the product of natural disintegration, and river distribution they would be expected to show some attrition incident to the long period of wearing they had passed through. On the contrary, while embraced in a water-washed and rounded sand, or fine gravel, they are themselves not worn in the least.

5. The quartz fragments, while mainly destitute of evidence of designed shape, do in a few cases appear to be imperfect forms of arrow-heads or of cutting or scraping instruments, and also have, along the edges, the appearance of having received repeated blows, and present small fresh surfaces of forced fracture.

6. In gathering about three quarts of these chips, eight pieces were found that could be thought to have a designed form, and two of these are of brown chert and undeniably the product of human design.

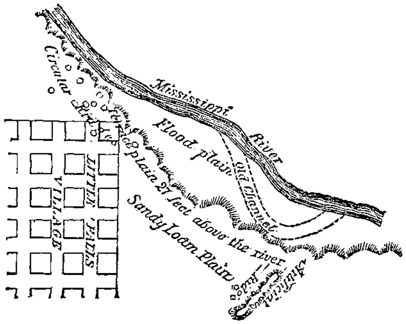
(Since the foregoing was written, some of these chips have been submitted to Mr. F. W. Putnam, Curator of Peabody Museum of Archaeology and Ethnology, Cambridge, Mass. After an examination he says he has no hesitation in saying that he "considers them identical with those known to be formed by the hand of man when making implements of stone." One of the chert specimens he regards "a finished implement.")

(2.) The Mound Builders.

Mention has already been made of ridges and mounds on the terrace at Little Falls attributable to the early race known as Mound Builders. They have a general resemblance to many others that may be seen in the State, some of which have been alluded to in former reports (Reports on Houston and Hennepin Counties). Their occurence at Little Falls is interesting especially in relation to the possible human origin of the quartz chips that have been described, as they seem to be of later date than the chips. This is proven by the fact that the mounds are built on the terrace plain, and of its materials, in the composition of which plain the quartz chips take part, extending three or four feet below the surface. The mounds themselves are somewhat different from those seen elsewhere, inasmuch as they consist of low, circular ridges, from eight to twelve feet across, rising but two or three feet above the general level. These are scattered over a small distance on the east bank of the river near the northwest corner of the village plat, though perhaps others would be discovered on making a more extensive survey. The following diagram of the surface shows their position relating to the river and the other ridges. They may have been designed for habitation, having been formed at first by slightly excavating the surface of the ground, and then building rude arched coverings supported by wooden branches and enclosed by earth. As these decayed and fell in, the resulting forms would be exactly what are now seen. Beyond the limits of the village, further north, is an interesting ridge, nearly straight, running obliquely back from the river and a hundred and eight paces in length. This is of a very different nature, though plainly artificial. It is from three to four feet high. It has two low spots, or openings through it, which separate it into three main parts. It does not extend to the immediate river bank, but is separated from it by an interval of several rods. The design of this ridge is not evident, but it must have had some relation to other works in the neighborhood. It may not however, have the same age as the small circular ridges above mentioned, since there is some possibility that the latter may have been built by the present Indian races.

About fifty earth-works or mounds are found on the border of a small lake on Sec. 35, Belle Prairie and Sec. 9, Little Falls, six miles east of the village of Little Falls. They follow round the shore of the lake, which is know by the Indians as "The Lake between the Hills."

FIG. 7.



Mounds and ridges at Little Falls,

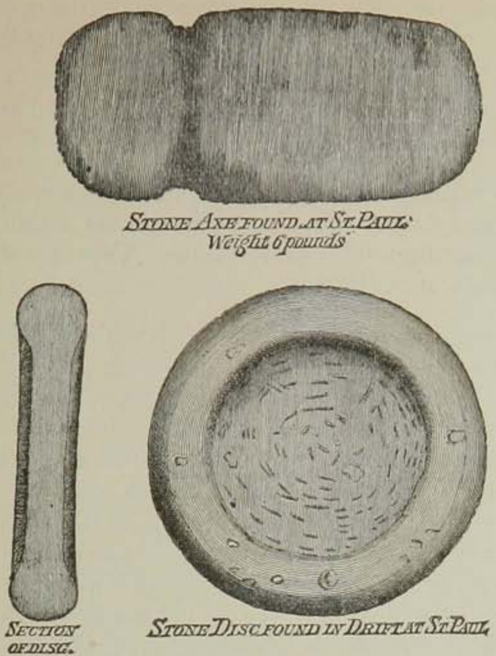
(3.) *In other parts of Minnesota.*

A great many flints and stone implements have been found in the State indicating the former prevalence of a race, or races, analagous to the stone-workers of Europe. Whether these stone implements are referable to the older stone-working race, which would make them pre-gracial, (palæolithic), or to the more recent nolithic stone-workers, or to both of them, has not yet been ascertained; but the disposition has been general to assign them to the latter. It may be possible, however, that the palæolithic race is represented, and the quartz chips at Little Falls would seem to indicate that to be the case. At any rate the most careful attention should be given to the relation of all such discoveries to the drift of the region in which they occur.

A few of the other evidences of palæolithic man in Minnesota may be mentioned. Dr. A. E. Johnson mentions in the Bulletin of the Minnesota Academy of Natural Sciences for 1874, the discovery of human bones in the sand and gravel of the Mississippi river in the eastern terrace bluffs, at Minneapolis, coincident in age and hight with the terrace bluff in which the quartz chips occur at Little Falls, this being a deposit coincident with or immediately following the last glacial epoch. On the same authority two fragments of a human lower jaw with teeth were discovered in the "red clay and boulder drift" near the Falls of St. Anthony, by workmen excavating in it for use in the tunnel under the river, lying "immediately upon the limestone ledge." This red clay is the product of the first, or oldest known, glacial epoch, and lies below all the other drift. He also states that on the same side of the river a copper spear-head was taken from a crevice in the limerock of the Lower Trenton, where its strike forms an elevation in the alluvial plain of the terrace above mentioned, at some distance from the immediate river, under four feet of drift—"sand, gravel and clay"—which is now in possession of the St. Paul Historical Society. This deposit is of the same plain and date, as the material of the terrace containing the quartz chips. The spear-head is said to have been three feet within the lime-rock. It must be admitted, however, that, supposing these human bones and teeth to have been found in the manner reported, they may still have been the result of more modern burials, and the spear-head may have been thrust in the crevice (a weathered and eroded jointage-plain) horizontally, instead of perpendicularly, as these open crevices abound in the Lower Trenton and appear on the exposed wall of the rock facing the river, and especially in that part of the ancient channel which was cut prior to the last glacial epoch, where this spear-head was found. The locality of the Falls must always have been a resort for rude tribes of men, and a great many burials, not to say battles, may have taken place here. Still there is an appearance of authenticity about these discoveries, so far as the published facts go.

A stone axe weighing six pounds was found at St. Paul in digging a cellar near the Adams school house, by Jacob Biska, six or eight feet below the surface. It was overlain by soil and black loam, which has a thickness of eight or ten feet at that point. The figure below shows its outline. The surface of the blade end is smoothed, or roughly polished, but the other end is rougher, or weather-worn. This lay in the latest of the drift deposits, but far beyond the reach of the present river, though within the outer drift bluffs.

FIG. 8.



Stone axe and disc found at St. Paul.

In a gravel bank at St. Paul also was found recently by Mr. Mervine, a stone disc about two inches in diameter, and three-quarters of an inch in thickness. This has a circular depression in the center. One side is coated with a limy crust. It is of a fine-grained greenstone.

The remains of an extinct elephant, in the form of a tooth and tusk, were found in the gravel and sand of the east bank of the Mississippi about five miles above Minneapolis. These occupy the same relation to the river and the valley as the quartz chips at Little Falls, having been taken from the same terrace.

In the coarse river-gravel at Stillwater, far above the present river, but within the main valley, was found a mastodon's tusk, and about eight feet of it are preserved in the Academy of Sciences at St. Paul. This was taken out in the year 1856 by A. Van Vorhes. The section of the bank in which it was found is now made up as follows :

1. Disturbed sand with some boulders.................... 5 feet.
2. Fine sand, with nearly horizontal strata................ 2 to 6 feet.
3. Gravel and boulders.................................. 0 to 4 feet.
4. Very fine, handsome sand, in horizontal stratification... 15 feet.
5. Coarse gravel and boulders............................ 4 to 6 feet.
6. Horizontal strata of fine sand.........................30 to 40 feet.
7. The "tripoli" bed lies next below this fine sand.

The tusk was found in No. 6, and near the bottom. Near the top of the same stratum, Mr. Van Vorhes found fragments of pottery having carving and ornamentation. These are all to be seen in the Academy at St. Paul.*

In the possession of the Minnesota Historical Society are two immense stone hammers recently obtained at St. Peter by Mr. B. M. Randall. One of these was found four feet under ground, and the other was on the surface. They each weigh fifty or sixty pounds. The adjoined sketch of their probable manner of use represents, if correct, probably the most primitive flouring-mill that Minnesota ever possessed. It was prepared by Dr. R. O. Sweeny. While these millstones each have a groove running about them, somewhat on one side of the middle, as if for receiving a withed frame, yet the groove of one appears as if it were of natural origin, and caused by the more rapid disintegration of a vein of micaceous granite or gneiss with which the groove is coincident, while the bulk of the stone is of a firmer rock. In the other, however, the groove has evidently been dug out by coarse artificial chipping.

These *upper millstones* were found at points two miles separate. One, the larger of the two, has the groove deep on one side, but less

*The importance of this "find" caused the writer to distrust his own notes, made in 1872, as to the exact position of the pottery, although taken down on the spot as described by Mr. Van Vorhes, and to make a fresh application to Mr. Van Vorhes for the particulars as to its *exact position*. The following from that gentlemen, who is an experienced surveyor and an exact observer, affirms the position of both as at first stated:

STILLWATER, April 26, 1877.

DEAR SIR:—Yours of the 16th came duly to hand, and found me almost helpless with a rheumatic attack, which explains my seeming neglect to answer your inquiry.

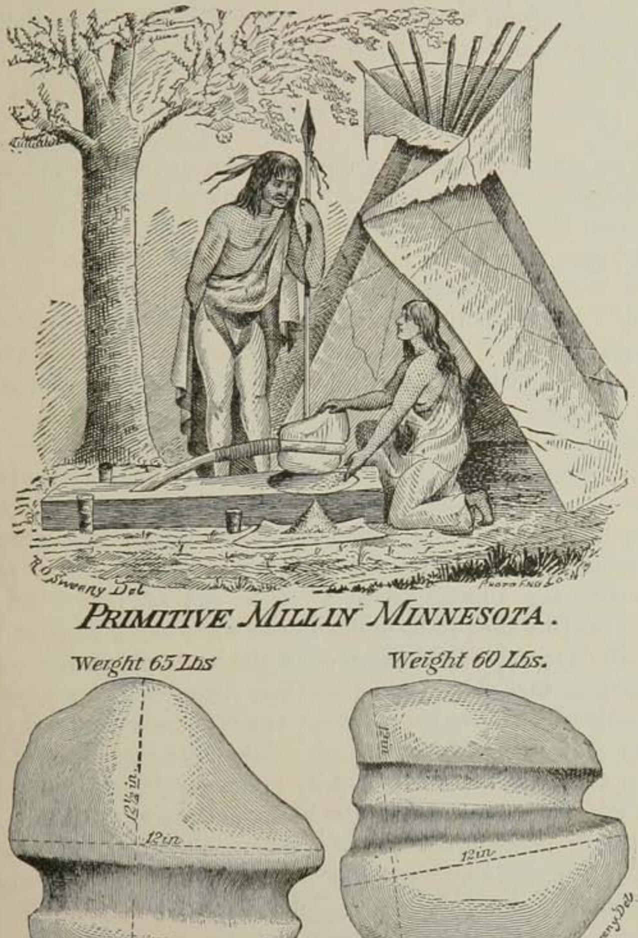
The mastodon tusks were found about eight or ten feet above the base of the hill: the hill at this point rises at an angle of about 45°. After excavating in the base of the hill on the grade of Myrtle street about 37 feet, the tusks were found, consequently 37 feet below the surface. At this point the hill was about 90 feet high.

The crockery I found some thirty feet farther into the hill and some six or eight feet higher in the strata. This hill is a continuous tongue of land lying between the Florence mill stream and a spring run. The two streams run parallel and some 350 feet apart. The hill is so steep on the Florence mill side as to be inaccessible except by clinging to roots and brush growing on it. The material at the base is sand and small gravel. Where the tusks were found the strata were pure sand ten or twelve feet thick, exhibiting clearly the direction of the current in an eastward inclination one or two degrees. On the top of the hill were heavy boulders of the drift period. I deeply regret that indisposition and the weight of eighty-four years have rendered me incapable of composing a satisfactory commmunication. Yours, with much esteem,

A. VAN VORHES.

noticeable on the other, and was found in 1876. It lay "under the ground, covered with black earth and sand, above a layer of chalky deposit containing some flint and other stones." It was on the rocky terrace formed by the Shakopee and Jordan formations near St. Peter, but a little south of the town, and thirty rods distant from the flood plain of the Minnesota river. The smaller one was found "two miles further south, just at the foot of the bank, among a lot of boulders of all sizes." It was found in August, 1874.

FIG. 9.



Primitive flour-mill and outlines of the upper millstones.

The phenomena of the mounds that are scattered all over the State cannot be regarded as palæolithic, since they pertain to a period subsequent to the last glacial epoch. The mounds are found indiscriminately at all levels, and in all relations to the drift deposits—even on the latest deposits. Remains that are found embraced within the actual drift, are classed here, according to Mr. James Geikie, as palæolithic. If they are in the gravel or sand along rivers or in the hardpan of the last glacial epoch they accompanied or preceded the last glacial epoch. If they are in the hardpan of the first glacial epoch they have a still older date. Under this grouping neolithic remains are only those of later date than the last glacial epoch.

The Soil of Morrison County.

The immediate river valley is rather sandy, and has reacted against the settlement of the county; but the general level of the country, away from the river, is of a very different character. There is a fine red loam that covers much of the land east of the river, which is of the same nature and date as the loam that is spread over the uplands in much of the southeastern portion of the State, and has given that section of the State a notoriety for ease of culture and fertility of soil, second to none in the United States. This loam in some places is rather coarse. It is, indeed, seldom clayey, as it is in Houston County, and in other places it is wanting, the soil then being a gravelly hardpan, or gravelly clay. The eastern portion of the county is mainly one of plain, or rises and falls in broad undulations, the valleys being occupied by the creeks that generally drain southward, or toward the Mississippi. On the west side of of the river the alluvial plains are wide, and are rather wet now, but they are destined to be drained, which can easily be done, when they will be found to possess some of the best soils in the county. The hardpan that closely underlies these flats sometimes appears in low knolls which have already been taken by settlers, as they rise slightly above the flats and furnish a different forest growth; while back of the flats is a series of drift bluffs furnishing heavy hardwoods, which correspond with the bluffs on the east side of the river. These bluffs introduce a belt of hardpan clay soils, and continue westward, through slight variations, to the Leaf Hills. Throughout this range, and scattered over the intervening surface, are frequent boulders of granite and of northern limestone.

Water Powers.

There is a fine water-power in the Mississippi at Little Falls, and a rocky island in the river makes its improvement more feasible. This was used at one time for milling and manufacturing purposes, but the dams have been swept out by the river, and the buildings themselves are entirely destroyed. The recent completion of the railroad north and south through the county, running on the east side of the river, is destined to hasten the settlement of this interesting county, and to develop more rapidly its great natural resources.

There are flouring mills already established at the following points:

On the Platte river, Sec. 35, Belle Prairie; three runs of stone, for custom work; also has machinery for cutting lumber. This is known as Grevel's mill.

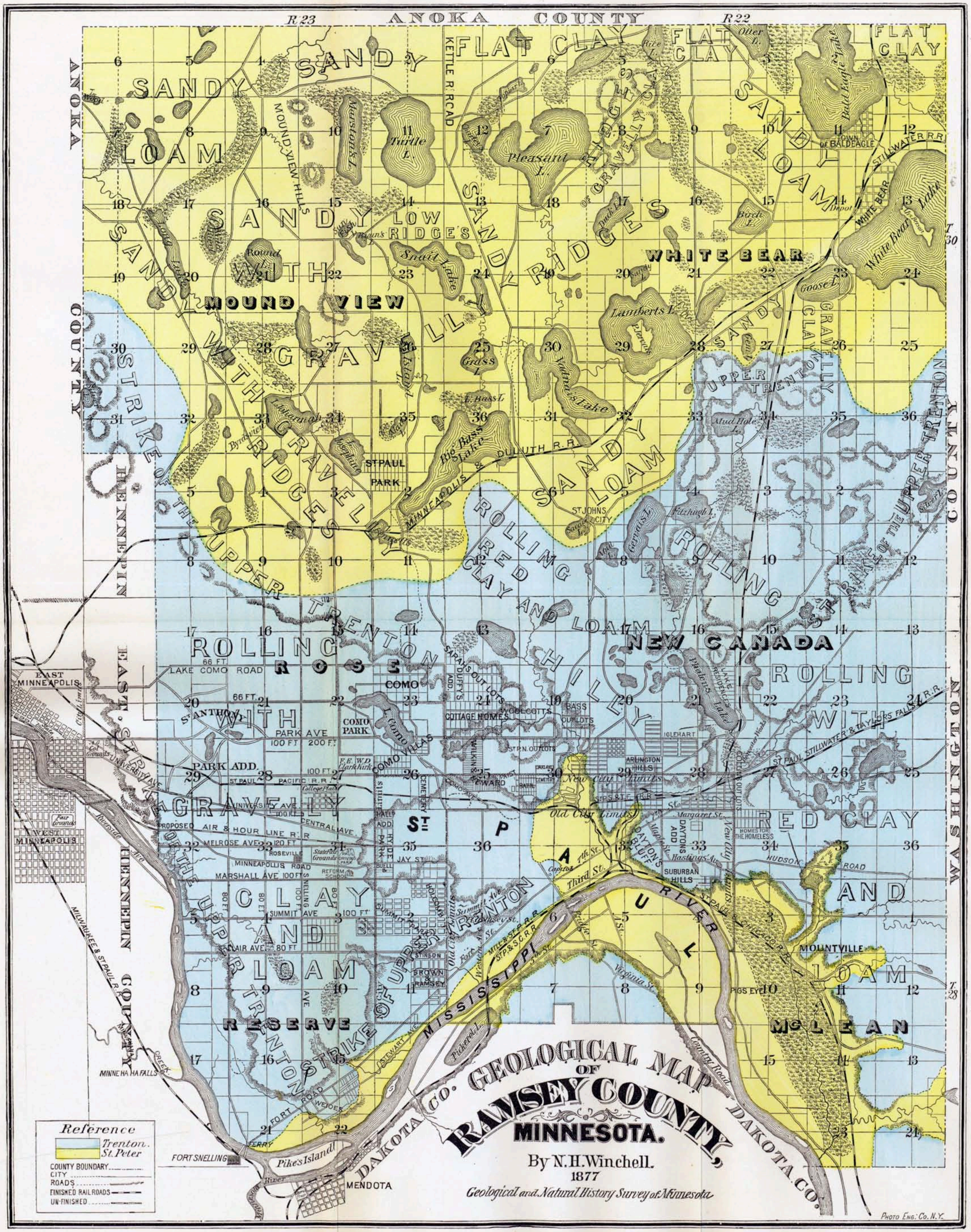
Hill Brothers' mill is at the mouth of the Little Elk river and manufactures flour and lumber. It has two runs of stone. and 12 feet water head.

V.

THE GEOLOGY OF RAMSEY COUNTY.

Situation and Area.

Ramsey county lies east of the Mississippi and embraces St. Paul, the Capital of the State. It contains 101,124.62 acres. It is nearly rectangular, but is indented on the south by a great northward bend in the Missippi river. On this bend St. Paul is situated. The following tabulated statistics show the areas of the different towns, and dates of survey. The territory here described as lying south of the Mississippi river was detached from Dakota county and added to Ramsey county by an act of the Legislatnre, approved, March 9th, 1874. The county has Hennepin and Anoka on the west, and Anoka on the north. Washington county, about eighteen miles wide separates it from Lake St. Croix, which is the eastern boundary of the state; separating it from Wisconsin:


GEOLOGICAL MAP OF RAMSEY COUNTY, MINNESOTA.
By N. H. Winchell.
1877
Geological and Natural History Survey of Minnesota
Reference
Trenton.
St. Peter
COUNTY BOUNDARY
CITY
ROADS
FINISHED RAIL ROADS
UN-FINISHED
ANOKA COUNTY
HENNEPIN COUNTY
WASHINGTON COUNTY
DAKOTA CO.
R 23
R 22
SANDY LOAM
FLAT CLAY
SANDY WITH GRAVELLY RIDGES
SANDY RIDGES
LOW RIDGES
MOUND VIEW
WHITE BEAR
SANDY LOAM
STRIKE OF THE UPPER TRENTON
ROLLING RED CLAY AND LOAM
HILLY
NEW CANADA
ROLLING WITH RED CLAY AND LOAM
ROLLING ROSE WITH GRAVELLY CLAY AND LOAM
RESERVE
McLEAN
MOUNTVILLE
ST PAUL
MISSISSIPPI RIVER
EAST MINNEAPOLIS
WEST MINNEAPOLIS
MINNEHAHA FALLS
FORT SNELLING
MENDOTA
Pike's Island
ST PAUL PARK
ST JOHNS CITY
COMO
COMO PARK
White Bear Lake
Bald Eagle Lake
Pleasant L.
Turtle L.
Snail Lake
Big Bass Lake
Vadnais Lake
Lamberts L.
Gervais L.
Phalens Lake
Como L.
MINNEAPOLIS & DULUTH R.R.
ST PAUL STILLWATER & TAYLORS FALLS R.R.
STILLWATER R.R.
MILWAUKEE & ST PAUL R.R.
PHOTO ENG. CO. N.Y.

SURVEYING STATISTICS OF RAMSEY COUNTY,

By F. E. Snow.

Township.	Range.	Township Lines.		Subdivisions.	Acres.	Remarks.
		When Surveyed.		When Surveyed.		
28	22	S. & E.	September, 1847	October, 1847	7,785.31	North of Miss. River, Sections 24, 25, 35 and 36 lie in Washington County
28	22	N. & W.	October, 1847			
28	22	S. & W.	July, 1853	September, 1853	2,475.62	South of Miss. River. Includes Sections 4, 5, 6, 7, 8 and 9, except the S. W. ¼ of S. E. ¼ of Section 7
29	22	N. E. S. & W.	October, 1847	November, 1847	22,467.09	
30	22	S. E. & W.	October, 1847	December, 1847	19,270.98	
30	22	N.	August, 1847			
28	23	N. & E.	October, 1847	October, 1847	8,158.17	North of Mississippi River
28	23	E. & S.	July, 1853	August, 1853	168.37	South of Mississippi River, Section 12
29	23	N. E. W. & S.	October, 1847	November, 1847	18,917.87	Sections 6, 7, 18, 19, 30 and 31 of this township lie in Hennepin County
30	23	S. E. & W.	October, 1847	December, 1847	21,881.21	
30	23	N.	August, 1847			
	Total area of Ramsey County				101,124.62	

The Surface Features.

With unimportant exceptions the northern third portion of the county is flat while the remainder is rolling or hilly. becoming more and more broken toward the Mississippi river. Thus rolling surface in the southern portion is due to the present *pose* of the drift materials, and not to any upheaval in the rocks. The rocks everywhere lie practically horizontal, but they have been eroded by streams in numerous instances, prior to the drift-epoch, so that there are deep valleys in the rocky surface. These valleys materially modified the manner of deposition of the drift, and determined its composition at special points. The drift materials seem to have been accompanied by more water, in the act of deposit in the level, northern portion, than in the southern, and have also, since their deposit, been smoothed off by the same agency, during the prevalences of a second glacial epoch. The loam that is spread over the most of the county is the sole product, in the most of Ramsey county, of this second glacial epoch, but it was spread by water instead of ice. Where the old drift clay is visible in the northern part of the county it appears as gravelly ridges rising slightly above the flat country round about, and is then but very slightly covered with the loess loam. This loam, however, is conspicuous and abundant over the most of the county, particularly in the eastern portions.

The Mound View Hills, in Mound View township, afford the most important instance of the prevalence of the old hardpan drift above the general flatness of the country in that part of the county. They are in Secs. 10 and 15, T. 30 N. R. 23 W. They rise about 100 feet abruptly above the valleys which separate them, and about 200 feet above Rice creek valley. They consist outwardly of red gravelly hardpan, but they probably have a nucleus of harder rock. Their remoteness from the main belt of the Trenton makes it less likely that their rocky nucleus is of that formation. The Potsdam sandstone, as a quartzyte, rises in monoclinal hills in other parts of the State round the areas of the St. Peter, and forms several such rocky knobs. In this case, if this quartzyte be the cause of these hills, the original rocky knobs served as gathering places for a greater abundance of morainic drift. For further illustrations of similar phenomena in Minnesota the reader is referred to the Second Annual Report p. 193. This series of knolls does not extend far in any direction, their principal elongation being N. and S. There are three principal hills. They are scantily timbered with Burr Oak. The lands about have comparatively but few Burr Oaks.

Natural Drainage.

The most of the county is drained southwardly into the Mississippi. But the streams are small, and expand into lakes at frequent intervals. In the northern part of the county, where the most of these lakes are situated, there is less diversity of surface, and sometimes the streams, and the lakes themselves, are skirted by extensive marshes or "hay meadows." In the northwestern part of the county the natural drainage is toward the northwest, and reaches the Mississppi through Rice creek. The Mississippi river, which runs along the southern boundary of the county, lies in a deep valley which is about two hundred feet below the general upland. The streams which enter it generally pass down this descent gradually at points several miles distant from the river itself. But above Fort Snelling the streams enter it abruptly, by plunging over the perpendicular bluffs of rock, by which the river is everywhere enclosed.

The lakes of the county are, some of them, large and deep, and contain pure and clear water. They have low shores, and are but little below the general level in the northern part of the county, but in the southern they are in deep basins in the general surface, having gravelly shores and frequently attractive natural surroundings. White Bear Lake in the northeastern part of the county, and Lake Como, near St. Paul, are the chief of these lakes that serve as summer resorts; though there are several other large, and perhaps equally pleasant, in the central part of the county. Some of these lakes are united by the St. Paul water works, and supply the city of St. Paul, through Lake Phalen, with water for public and domestic purposes. This line of water works, by means mainly of artificial connections, takes its supply from Pleasant Lake, passes through Vadnais Lake (connecting here also with the waters of Bass, Lambert's and Goose lakes), enters Gervais Lake, then Spoon Lake and finally discharges from Phalen Lake through an acqueduct, into St. Paul. Thus an artificial water-course is established from the northern to the southern boundary of the county—Rice lake, the most distant with evident connection, being on the northern boundary, partly within Anoka county.

The water that issues at Fountain Cave, St. Paul, is that of a creek which disappears in the ground about half a mile distant—toward the city.

The knolls themselves are evidently "kames," and in studying their cause all the problems of the glacial epoch are brought before the mind. They are now supposed to have been formed, so far as the drift is concerned, in the beds of streams of water running on and through the ice, and in openings like great crevasses formed by the underlying rocky knobs, as the ice-sheet passed over them. These hills are conspicuous objects in the horizon from distant points in all directions. They are visible from the high land in Reserve township, Sec. 16, T. 28 N. R. 3 W., and from their summits can be seen Anoka, Hamline University, the Reform School, the spires and smokes of Minneapolis, some of the buildings of St. Paul, and the village of Centerville. This view is more extensive, but not so interesting as that on the peninsula on Sec. 16, Reserve, from which point these hills can be seen, and a fine view can be had over the valleys of the Minnesota and Mississippi covering Fort Snelling and Minneapolis at nearer range.

There is another cluster of lower clayey and gravelly ridges in the northwestern part of White Bear Township, and an outlying area of Upper Trenton, causing a high tract in the southern part of the same township.

The southern part of the county, mainly occupied with the Trenton formation, is generally higher than the northern. The drainage courses which pass through it toward the Mississippi lie in deep valleys, which are surrounded and hid by hills and ridges of drift. These hills probably are due primarily to a rock-sculpture, older than the drift, but the drift is so thick that the rock seldom appears in exposure above the surface. There is some appearance of the former extension of the valley of Rice Creek much further southward, and it is no unreasonable suggestion that the great Mississippi itself may have once occupied this valley, entering the great gorge again where it becomes remarkably widened at St. Paul; but the evidence is entirely topographical. Such as it is, it is perhaps over-balanced by a confusion of hills and high drift-ridges north of St. Paul, which render it improbable that the Trenton is anywhere entirely cut through from the Rice Creek valley to St. Paul, as would have been the case if the Mississippi ever passed through there. Other evidences of this hypothetical position of the Mississippi north of St. Paul are mentioned under the head of Drift.

Description of the Towns of Ramsey County.

T. 28 N. R. 22 W. (*Fractional*) *S. part of* McLean *and part of* St. Paul.

This town shows the extremes between high rolling or hilly land and low alluvial flood plain. The bluff portion east of the Mississippi is about a mile and a half wide and three miles long, running north and south, and is cut by east and west valleys and by tributary creeks, so as to have a rough or hilly surface. It is considerably more than half covered with small timber (oaks and aspens.) The rest of this town east of the river is low, and largely occupied by hay meadows or by marsh. A belt of soft timber growing to large dimensions, separates it from the river channel. On the west side of the river there is a repetition of these features, but in reverse order. W. St. Paul is embraced in this portion. Area in Ramsey County 10,260.93 acres.

T. 29 N. R. 22 W. New Canada, *with N. part of* McLean *and N. E. part of* St. Paul.

This town has a rolling or hilly surface, and is about half covered with timber. Toward the north it is more flat. Through the central portion passes the canal of the St. Paul Water Works and Phalen's Creek. It has several large lakes and also several marshes, but the most of the town is arable agricultural land. Area, 22,-467.09 acres.

T. 30 N. 22 W. White Bear.

This town is mainly flat, and embraces a greater water area than any in the county. It also has several large marshes in the northern and central portions. It has a small area of more elevated land in the northwestern corner, east of Pleasant Lake, and another in the southwestern, south of White Bear Lake. The subsoil is a gravelly clay, which sometimes rises to form also the soil, but the surface soil is usually either a sandy loam, which sometimes becomes too light for good farming, or is a clay with a flat surface. Area, 19,270.98 acres.

T. 28 N. 23 W. (*Fractional.*) Reserve, *and W. part of* St. Paul.

This town has a rolling and generally a gravelly clay surface, and is either timbered with small oaks and aspens, or is of rolling prairie. It is diversified on three sides by the bluffs of the Mississippi. It contains no lakes and but few marshes. Area, 8,326.54 acres.

T. 29 N., 23 W. (*Fractional.*) ROSE, *and N. W. part of* ST. PAUL.

The southern part of this town is high and rolling, with a red clay subsoil. The northern part is more sandy and flat, embracing the portion round Lake Josephine and the southern part of Big Bass Lake. It also contains Lake Como, with a number of other minor lakes, with several marshes. These are mainly in the northern portion. Sections 16, 17, 21 and 22 are mainly of prairie. The rest of the town is well timbered. Area, 18,917.87 acres.

T. 30 N., 23 W. MOUND VIEW.

The hills already described, near the center of this town, give it its name. Aside from these hills and a tract along the S. W. corner, the whole town is flat or gently undulating, and has a rather sandy soil. This sand, however, is closely underlain by an impervious clay, as evinced by the numerous lakes and marshes which are found within its limits. Rice Creek is a slow, crooked stream, frequently skirted with marshes or hay meadows. The town is somewhat more than half covered with small oaks, with aspens and elms in the low grounds. Area, 21,881.12 acres.

Elevations in Ramsey County.

	Above the Ocean.
Lowest known water in the Miss. R. at St. Paul	676 feet.
Highest known water in the Miss. R. at St. Paul	697 feet.
Summit between White Bear Lake and St. Paul (8 feet cut), according to the St. Paul and Duluth R. R	959 feet.
Junction at White Bear Lake, St. Paul and Duluth R. R	920 feet.
St. Paul and Pacific Depot, St. Paul	689 feet.
Base of the Capitol, St. Paul	782 feet.
Bluffs back of the Capitol, head of Robert street	901 feet.
Summit avenue bluff	910 feet.
Junction of the St, Paul and Pacific and the St. Paul, Stillwater and Taylor's Falls R. R.'s	762 feet.
Crossing of the St. Paul and Duluth and St. Paul, Stillwater and Taylor's Falls R. R.s	
Grade of St. Paul and Duluth R. R	817 feet.
Grade of St. P., S. & T. F. R. R	797 feet.
Grade of the Mil. & St. P. R. R. at Dayton's Bluff	696 feet.

Soil and Timber.

The southern half of the county has a clayey subsoil, with a clayey lœss-loam overspread; and in general the northern, more flat, portions have the same subsoil, with a sandy lœss-loam overspread. There are, however, many spots where the lœss-loam is thin or wanting, where the subsoil constitutes also the soil; but in the southern rolling portions this circumstance is likely to afford a clayey soil, while in the northern this clay is more gravelly. Along the Mississippi River is a large area of alluvial land, which is so wet that it cannot be depended on for general farming, but furnishes a great deal of wild hay. There are also some higher flats along the river that are very fine for farming. The county, however, is not generally occupied for farming, but is owned by non-residents.

The following species of trees and shrubs were noted in the examination of the county.

Quercus coccinea. *Wang.* Var. tinctoria. *Bartram.*

[NOTE.—This is the tree that has been named *Quercus rubra L.* with doubt, in former reports. It is what is known oftenest as "Black Oak," but also is called "Quercitron," and "Yellow Barked Oak." Careful observations were made in the survey of this county on this oak. There was a specially favorable opportunity in West St. Paul, where were seen evidently two species, of oak, the black and the red, yet nearly alike, growing in a ravine in the same situation. This was near the "Farmer's Hotel" on the E. side of the street. They were here in company with white oak. The two species here growing under the same circumstances showed constant differences. Several trees here, of each, are of about the same size, but small. The general habit and color of the two are the same, except that the red is more open-branched, and looser in the top, having fewer dead twigs and branches. The chief distinctions are in the leaf and fruit. The red-oak leaf has the same general shape, and the same number of toothed lobes as the black, but the central undivided portion is wider than in the black, and the whole leaf is longer in proportion to its full width; hence its foliage is coarser and heavier than in the black. The leaves of the red droop, while those of the black turn easily with the wind, and stand in all positions. In the fruit, the acorn of the red is double the size of that of the black, both growing on last year's wood; the acorn of the red rising three or more times the hight of the shallow cup, while that of the black only rises about twice the hight of the cup. The cup of the red is generally an inch across; that of the black about half an inch or a little more.

This is by far the most abundant oak in the county, as it is throughout the southern half of the State; but there are some situations, particularly exposed, high hillsides, like the tops of Mound View Hills, in which it is noticed to fail, though growing abundantly on lower levels, and to be replaced by the Bur Oak. It does not frequently appear as a large tree, but is generally less than ten inches in diameter, or simply has the size of shrubs, intermixed with Bur Oaks of the same size.]

Quercus rubra. *L.* Red oak.

[NOTE.—At present this oak must be restricted to the only point at which it has been identified, *viz.* West St. Paul.

Quercus macrocarpa. *Michx.* Bur Oak.
Quercus alba. *L.* White Oak.
Ulmus Americana. *L.* (Pl. Clayt.) Willd. American Elm.
Populus tremuloides. *Michx.* Aspen.
Populus grandidentata. *Michx.* Great-toothed Poplar.
Populus monilifera, *Ait.* Cottonwood.
Tilia Americana. *L.* Bass.
Negundo aceroides. *Mœnch.* Box Alder.
Juglans cinerea. *L.* Butternut.
Carya amara. *Nutt.* Bitternut.
Fraxinus Americana. *L.* White Ash.
Fraxinus sambucifolia. *Lam.* Black Ash.
Acer rubrum. *L.* Red Maple.
Acer saccharinum. *Wang.* Sugar Maple.
Betula alba. *Var.* populifolia. *Spach.* (?) White Birch.

[NOTE.—About some of the lakes becomes 12 and 14 in. in diameter.]

Larix Americana. *Michx.* Tamarack.
Juniperus Virginiana. *L.* Red Cedar.

[NOTE.—Large trees grow at Lake Johannah, and also along the rocky bluffs of the Mississippi.]

Salix nigra. *Marshall.* (?) (And other willows).
Ulmus fulva. *Michx.* Slippery Elm.
Prunus serotina. *Ehr.* Black Cherry.
Pinus Strobus. *L.* White Pine.

[Only along the banks of the Mississippi above Fort Snelling.]

Betula excelsa, *of American authors.* Gray Birch.

[At Lake Johannah.]

Prunus Pennsylvanica. *L.* Small Red Cherry.
Prunus Americana, *Marsh.* Wild Plum.
Zanthoxylum Americanum. *Mill.* Prickly Ash.

Ostrya Virginica. *Willd.* Ironwood.
Carpinus Americana. *Michx.* Water Beech.
Prunus Virginiana. *L.* Choke Cherry.
Amelanchier Canadensis. *Torr and Gray.* Juneberry.
Pyrus coronaria. *L.* American Crab Apple.
Rubus occidentalis. *L.* Black-Cap Raspberry.
Rubus strigosus. *Michx.* Red Raspberry.
Rubus villosus. *Ait.* High Blackberry.
Ribes Cynosbati. *L.* Wild Gooseberry.
Ribes rotundifolium. *Michx.* Smooth Wild Gooseberry.
Ribes lacustre. *Poir.* (?) Swamp Gooseberry.

[Has a smooth fruit in racemes.]

Sambucus Canadenses. *L.* Elderberry.
Spiræa opulifolia. *L.* Ninebark.
Spiræa salicifolia. *L.* Meadowsweet.
Celtis occidentalis. *L.* Hackberry.
Alnus incana. *Willd.* Speckled Alder.
Alnus serrulata. *Ait.* Smooth Alder.

[NOTE.—Both alders are found, often in company, on the flats about White Bear Lake, but the smooth rarely exceeds three feet in hight, the other being ten or fifteen.]

Amorpha canesceus. *Nutt* Lead Plant.
Amorpha fruticoso. *L.* False Indigo.

[This has very much the appearance of a small locust.]

Aristolochia Sipho. *L'Her.* (?) Pipe Vine.
Rhus glabra. *L.* Smooth Sumac.
Rhus typhina. *L.* Staghorn Sumac.
Rhus Toxicodendron. *L.* Poison Ivy. (Tuttle Lake.)
Vitis cordifolia. *Michx.* Frost Grape.
Symphoricarpus occidentalis. *R. Br.* Wolfberry.
Corylus Americana. *Walt.* Hazel.
Cornus florida. *L.* Flowering Dogwood.
Cornus sericea. *L.* Silky Cornel.
Cornus alternifolia. *L.* Alternate-leaved Cornel.
Cornus paniculata. *L'Her.* Panicled Cornel.
Ceanothus Americanus. *L.* Jersey Tea.
Vaccinium corymbosum. *L.* *Var.* amœnum. Swamp Blueberry.
Lonicera parviflora. *Lam.* Small Honeysuckle.
Celastrus scandens. *L.* Bittersweet.
Ampelopsis quinquefolia. *Michx.* Virginia Creeper.
Rosa blanda. *Ait.* Early Wild Rose.
Viburnum Opulus. *L.* Highbush Cranberry.
Cornus stolonifera. *Michx.* Red-osier Dogwood.
Cratægus coccinea. *L.* Thornapple.

There is but little heavy timber in the county; yet it is nearly all covered with small trees and shrubs. The uplands and the flat parts of the county are furnished with black and bur oaks and poplar. The rest of the above species of trees are found in exceptional situations, as along the shores of lakes or streams, or in the flood plain of the Mississippi river. Several species are also peculiar to the rocky bluffs.

THE GEOLOGICAL STRUCTURE.

The formations that will here be described, embraced within the county, are as follows:

1. The St. Peter Sandstone.
2. The Lower Trenton Limestone.
3. The Green Shales.
4. The Upper Trenton.
5. The Drift.
6. The Loess Loam.

The St. Peter Sandstone underlies the northern flat and sandy portion of the county and the alluvial portions along the Mississippi, outcropping in the bluffs.

The Lower Trenton is that quarried at St. Paul, and its area is not distinctly separable from that of the other three members of the Trenton. These, taken together, underlie the hilly and clayey parts round St. Paul and extend in diverging arms, one toward the northeast and one towards the northwest. Between these arms, which embrace all three parts, is an area which includes the northwestern parts of New Canada and the northeastern parts of Rose townships, that is probably underlain only by the Lower Trenton. All of these members underlie the township of Rose in general, and the eastern part of New Canada. They would also be found in the high portions of the eastern part of McLean. The key to this distribution is found at St. Paul, and in the hills south of White Bear Lake, where certain features of the topography are found to coincide with their presence, and another set of topographical features to prevail in their absence. These topographical indications are almost the sole guide in thus assigning the parts of the Trenton to different parts of the county, on account of the abundant drift with which the county is covered.

The St. Peter Sandstone.

This sandstone is seen in the bluffs of the Mississippi from Fort Snelling to the southeastern corner of the county; and by reason of the breaking down of the overlying Trenton wherever former drainage streams have run, and the easy erosion of this rock, it also becomes the surface rock in a number of tributary valleys. In the city of St. Paul there is a large expansion of the St. Peter area over the low level through which Phalen's creek, and others, enter the Mississippi, which extends more than a mile north of the river. Further south are several such re-entrant areas in McLean township. The wide bottom-land east of the river, in McLean township, is represented on the geological map of the county, as St. Peter, but it is possible that the Shakopee limestone, which is shown at Red Rock, some further south, extends as the surface rock within Ramsey county, under the alluvium of the floodplain, but it is nowhere visible. At the most it can occupy but a small area. The St. Peter is about 150 feet thick. It has no noteworthy variations of character, as far as seen in Ramsey county, and it has already been described so many times that its lithological features need not be delineated again.

The Lower Trenton.

This is what Dr. Owen styled "St. Peter's Limestone," in his final report on the Geology of Wisconsin, Iowa and Minnesota, and which Dr. B. F. Shumard divided into:—

1. Upper Shell limestone.	F. 3. c	6 ft.
2. Non-fossiliferous Bed.	F. 3. b	5 ft.
3. Lower Shell limestone.	F. 3. a	23 ft.

In later reports, particularly those of the Wisconsin geologists, they were designated as the "Buff Limestone," and the "Blue Limestone," the former lying below the latter. These terms, however were strictly applicable only to formations in Wisconsin, but by inference were extended to cover the geological horizon at St. Paul and the Falls of St. Anthony. The Blue Limestone, however, of northern Wisconsin seems to have been regarded by Dr. Lapham as the equivalent of the Hudson River Group, of New York, and also of a formation of the same name in Ohio, where the term originated, and supposed to lie entirely above the proper Trenton.* These

* When this term was originally applied to the Ohio rocks they were regarded as a continuation of the Trenton limestone of New York.

terms seem still the more inapplicable to the limestones seen at St. Paul and St. Anthony Falls, since the terms "buff" and "blue" should be in reverse order. The "Lower Shell limestone" is more frequently blue than the Upper Shell limestone, and is always so on fresh quarrying. The latter is rather a dirty gray or drab, appearing somewhat like a fine-grained sandstone, and is often harsh to the touch.

Later still the whole of the limestone exposed at St. Paul was classed by Prof. James Hall as the equivalent of the Wisconsin "Buff Limestone," the "blue limestone" being some higher member not distinctly recognized in Central Minnesota, but in the light of further observations now known to be what has been designated by this survey as the "Upper Trenton," at its chief exposures in the southern part of the state, but which has not until the present been discovered as far north as St. Paul. At the same time (Geology of Wisconsin, Vol. I, p. 33.—1862.) Prof. Hall regards the Buff Limestone as the equivalent of the New York "Birdseye" and "Black River" limestone. In the meantime, the "Blue Limestone" in Ohio has become enlarged into the "Cincinnati Group," and the Trenton in that state involved so closely with it that its identity is nearly or wholly lost. On the west of the Mississippi, however, the Trenton has been shown to have a full development, and even to take on a peculiar phase designated "Galena," while the aluminous phase so largely developed at Cincinnati has only been recognized in the "Maquoketa Shales" of Dr. White.

Still more recently Prof. Chamberlain, of the Wisconsin survey, has shown (Geology of Wisconsin, Vol. II, 1873-77) that the lithological differences commonly relied on to distinguish the "blue" from the "buff" are not general nor reliable; that there is no chemical distinction which holds good, and that the fossils of the "buff," as heretofore limited, are also to be found above the "blue." Hence he regards them as essentially one. Further, in the northern part of the State he states that even the *Cincinnati Shales and Limestones* are undistinguishable by any satisfactory line of demarkation from the Trenton limestone, and includes that with the rest, under the general term "Trenton Group."

With these preliminary remarks it will be understood that the term *Lower Trenton* is not supposed to convey any greater significance than an appropriate designation for a local lithological phase, by which the lower part of the great Trenton Group is easily distinguished from the rest in the state of Minnesota.

Wherever the base of the Trenton has been seen in Minnesota, it has been found to consist of about 25 feet of calcareous firm beds (sometimes with some shaly layers), which give great prominence to this geological horizon in the topographical effects which they produce. They are underlain by an erosible sandrock, and overlain by a varying thickness of green shale. The underlying sandrock crumbles away, letting the limerock project, but the overlying shale sheds the surface waters that would otherwise disintegrate the limerock. These combine to preserve the limerock and to cause it to project in long, prominent headlands, and to form the brows of ridges and terraces which diversify several counties in the southeastern part of the state. The thickness of the overlying shale has heretofore not been supposed to exceed twenty feet, but observations made in Ramsey county go to show that the whole upper Trenton, so called in the southern part of the state, is here changed to a calcareous shale, with thin limestone layers, perfectly comparable to the Cincinnati shales and limestone of Ohio.

In Ramsey county this lower Trenton, or "Buff" limestone, as Dr. Owen at first designated it, is separable into three parts which have pretty constant characters, and they are approximately as given above from Dr. Shumard.

1. Impure, harsh, drab or dirty buff limestone, containing lumps of calcite and species of *Strophomena* and *Orthis*, with other fossils.......... 6-10 feet.
2. Shale, and calcareous shale with fragments of fossils..... 6-10 feet.
3. Limestone, with aluminous partings. This is the building stone of St. Paul. The mingling of shaly and calcareous parts throughout this limestone causes the dressed surfaces of large slabs to have a blotched or mottled surface, particularly when the dressed side coincides with the natural bedding. This member is the most persistent of the Lower Trenton, but splits into thin layers on long exposure, due to the loosening of the shale throughout the mass. This contains fossils characteristic of the Trenton, but generally in fragmentary condition.............. 15 feet.

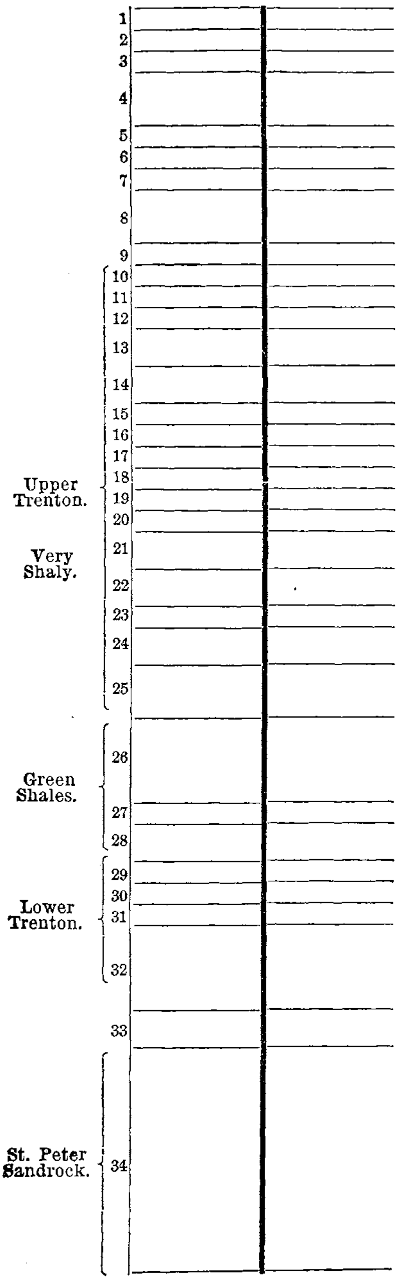
Besides the three main parts above described there are also several thin beds of green shale in No. 1, which seem not to be confined to any definite horizon, and nearly always a layer of green shale below No. 3.

In sections of the bluffs at St. Paul given in Dr. Owen's final report, this limestone is represented as greatly broken and even faulted along the river from Fort Snelling to St. Paul and especially in the vicinity of New Cave (now known as Fountain Cave) near the railroad bridge of the Milwaukee and St. Paul R. R. This locality was specially examined. The layers of the limerock are, it is true, disturbed along the immediate river bluff and are mixed in some confusion with coarse drift, but at points further from the river the beds continue along horizontal and unbroken, so that the formation itself cannot be said to be disturbed. Dr. Owen attributes rightly this broken condition, so far as the blocks seem to lie on drift materials, to the action of water, and probably that of the river at some higher stage. The beds were undermined and dislodged, but were not transported. Probably floating masses of ice, during the last glacial epoch which did not extend as a continuous ice-sheet east of this place, in Minnesota, played an important part in displacing these limestone blocks, and in depositing among them the water-worn drift.

The Green Shales and Upper Trenton.

The first intimation of the existence of any rock *in situ* in Ramsey county, above the Green Shales as they have been described in counties further south, and in Hennepin county, was found in the drilling of the well at the State Reform School near St. Paul. This was ordered by the legislature of 1877, and was done by C. E. Whelpley of Minneapolis. Mr. F. McCormick, Secretary of the State Reform School, has furnished the following:

Notes of the Deep Well Bored at the State Reform School, in the Months of April and May, 1877.



	Feet.
1. Two feet black soil	2
2. Three feet gravel	3
3. Six inches clay	0½
4. Thirteen feet coarse gravel	13
5. One foot fine sand	1
6. One foot coarse gravel	1
7. One foot fine sand	1
8. Thirteen feet coarse sand	13
9. Two feet boulders	2
10. Three inches lime rock	0¼
11. Three feet clay	3
12. Two feet sand, with water	2
13. Six feet three inches shell rock with clay	6¼
14. Seven feet hard lime rock	7
15. Two feet clay	2
16. One foot hard rock	1
17. Four feet blue clay	4
18. Four feet hard rock	4
19. One foot blue clay	1
20. Three feet lime rock	3
21. Six feet clay, light color	6
22. Five feet clay, dark color	5
23. Four feet yellow clay	4
24. Five feet blue clay	5
25. Eight feet blue clay (very hard)	8
26. Twenty-eight feet blue clay	28
27. One foot lime stone (hard)	1
28. Six feet blue soap stone	6
29. Three feet lime rock	3
30. Three and one-half feet blue soap stone	3½
31. One and one-half feet lime rock	1½
32. Twenty-eight and one-half feet blue lime stone	28½
33. Five feet blue clay	5
34. Seventy-seven and one-half feet white sand rock	77½
Whole depth	252

An abundant supply of water was obtained at the depth of 150 feet. This supply, however, was not tested until after the well had been bored one hundred feet below it. The drill at that point, became fixed and immovable, so that the contractor was wholly unable to proceed further, when, after experimenting with pumps, it was found that the supply was sufficient for all practical purposes.

The water was obtained after drilling about ten feet in the lime rock of No. 32.

From this source the water rose in the well about eighty feet. The water is supposed to be of excellent quality.

Of these, No. 34 is plainly the St. Peter sandstone. No. 33 is the green shale which is nearly always seen over the sandstone in Hennepin and Ramsey counties. Nos. 32 to 29, inclusive, include the Lower Trenton, but the thickness seems greater than elsewhere observed, being 36½ feet. The rest of the drill seems to be taken up with alternating shale and limestone layers, the greater portion being of shale. Of this thickness (101½ feet) probably the main mass of shale, near the bottom, said to have been 28½ feet thick, represents the green shales that had before been identified; but there is not sufficient difference between this and the rest to exclude the application of the same term to the whole of the beds above No. 29.

A few months later an exposure of green shale was seen in the road, N.W. ¼ Sec. 9, in Reserve, accompanied by *Chœteets* and *Orthis*, above the level at which the regular green shale could exist. Blocks of fossiliferous blue limestone were also seen abundantly along a ravine in the same township, (Sec. 15) mixed with the debris of the red hardpan clay, far above the level of the Lower Trenton; a circumstance at variance with any thing before seen in Ramsey county. Finally, the beds in place were found in a good exposure along Ramsey street in St. Paul, where it ascends St. Anthony Hill. They were first seen in a little artificial ravine made for a watering tank. They are exposed in a similar manner in other ravines that descend St. Anthony Hill toward the river, farther west. The basis rock of St. Anthony Hill is the same. Their thickness above the Lower Trenton is 108 feet, and they have a conspicuous strike, as already stated, in a line of drift-covered bluffs that run from St. Paul northwestwardly, reaching Anoka county south of Rice creek, causing the high and hilly land there seen. These beds also form the nucleus of the high land that extends from St. Anthony Hill southwestwardly toward Fort Snelling, distant about three-fourths of a mile from the river.

These beds are very shaly, not more than one-third of the whole being limerock, and contain the usual fossils of the Lower Trenton, but their paleontology has not yet been examined carefully. The whole formation seems to have the characters of the Cincinnati, as exposed in Green Bay, Wisconsin, or in Ohio.

The Trenton Group.

In New York the Trenton limestone is succeeded by a mass of shales with the local designations, Utica slate, Frankfort slate, Shales and sandstones of Pulaski, and Lorraine shales. These were all embraced in the term Hudson River Group, which had before been applied to a mass of shales that are now known to be much lower. On account of this error the term Cincinnati Group has been generally substituted.

On the other hand in Iowa and southern Wisconsin and Minnesota, the Trenton limestone is found to pass into the Galena by slow stages and to be followed, at least in Iowa, by a greatly reduced representative of the Cincinnati Group, named by Dr. White the Maquoketa shales. Leaving Iowa and passing into Minnesota the Trenton limestone increases in thickness, and the Galena diminishes, the latter becoming interstratified with beds of shale. In Olmsted county, still further north, the Trenton also contains numerous beds of shale and the Galena is still further reduced. The beds are traceable by continuous or frequent outcrops throughout Goodhue and Rice counties, with an increasing amount of contained shale in the Trenton, and finally with the total loss of the Galena. On account of the soft and shaly nature of the upper beds, by the time they reach Ramsey county they are so covered with the greater drift accumulations that their presence so far north had not before been suspected. Here is an ascertained horizontal change in the character of the beds of this formation, between the southern and central portions of Minnesota, which brings up the question as to the designation they should bear at St. Paul. They are the horizontal equivalents of what has been recognized as the Trenton formation in the southern part of the State, and in neighboring States, and contain the same fossils; but they have the lithological character and the geological position of another well organized group of rocks in Ohio and northern Wisconsin. The eastern Cincinnati fossils are also the western Trenton fossils. Here we have two equally well established names for the same series of beds.

The cause of this gradual change in the formation from dolomitic limestone to a pure limestone, and then to an argillaceous limestone, and at last to a mass of calcareous shales, is to be sought for in the character of the ocean's bed, and the nature of the water and its currents, in the Silurian ocean. And here it is only necessary to apply a well known law of ocean sedimentation, viz.: *the nearer the shore the shallower the water, and the coarser the sediment.* This seems to make dolomitic limestones in the deepest waters, ordinary limestone in deep water, and shales and sandstones in shoal water. The strike of the formation under consideration passes through all these conditions and directly toward the metamorphic area of the State which lies but little further north. Hence, at St. Paul the water was much shallower than at Rochester, and the sedimentation was much coarser; while at Rochester there was much more shaly sediment than at Dubuque. The direction of the strike of these rocks in New York State is along the shore-line of the ancient ocean, and hence the opportunity for noting this change was much less favorable. In Wisconsin and Minnesota the strike is north and south, and in Minnesota rapidly approaches the ancient shoreline.

The Drift.

While the county is wholly covered with a red hardpan clay, believed to be of the age of the first glacial epoch, it shows some variations that require special mention, and is also furnished with a lake deposit which forms the surface soil.

At St. Paul the red hardpan is found uniformly in excavating for buildings in all that low area about the levee, and in the deep cuts through the gravelly bluff north of E. Third street. Although here it is covered with sometimes more than forty feet of lighter-colored drift materials, it emerges from under these immediately on getting outside the valley either north or south, and is covered, but sometimes thinly, with the loess loam. This overlying loose drift is found along the Mississippi valley throughout the county, and everywhere shows the action of water in its deposit. It very seldom contains any clay, and when it does the clay is stony and has a different color from the red hardpan clay. Above Fort Snelling, and in the western part of Reserve and Rose townships, the red hardpan has not the same clayey and unmodified character that it has in the eastern part of the county. It seems to have been washed by water, and in that manner to have lost some of its clay, while there are localities where materials of a different color, particularly gravelly deposits, are superimposed or mixed with it, so that sections seen along the western part of University Avenue have a confused arrangement and mingling of the coarse water-worn materials of both the red hardpan and the gray, with occasional patches of gray hardpan. This water-washed condition also prevails in the low gravelly knolls and ridges that are seen occasionally in the northern flat part of the county, but without any intermixture of materials referable to the gray hardpan. In the high and rolling tract occupied by the Upper Trenton, this red hardpan shows to the best advantage, whether in the western or eastern part of the county. In the deep excavations made in St. Paul this red hardpan is seen to be overlain by a fine red laminated clay, which is probably of the same nature and origin as the so-called *Tripoli* found at Stillwater, the thickness of which sometimes reaches six or eight feet, but which in some places is entirely wanting. This seems to be related to the underlying hardpan sheet somewhat as the laminated brick clays and loams of later date are to the gray hardpan which they overlie, and was deposited during the waning period of the former glacial epoch, and when water was abundant but comparatively quiet.

What has now been described, *i. e.* the red hardpan and the red laminated clay overlying it, were the products of a glacial epoch which brought its materials from the north and northeast, the red color being due to the prevalence of the debris of red sandstone, shale, and other iron-charged rocks that are developed largely in the vicinity of Lake Superior. Whether this ice-period preceded or followed the excavation of the immense gorge of the Mississippi which is visible southward from Dayton's Bluff in St. Paul, is not ascertained by any observed facts, but several considerations would require a date subsequent to that excavation—or to the greater portion of it. It is probable the Mississippi began to excavate that gorge at the time of the elevation that brought the upper Trenton (or the Cincinnati) above the Silurian ocean, an event which has been taken to divide the Silurian in America into two parts, the upper and the lower. In that case it is the oldest portion of the Mississippi gorge at present known, and has since that event carried off the waters of the Metamorphic land areas of Wisconsin and Minnesota. The St. Croix valley seems to be equally old, and perhaps served for the drainage mainly of the Wisconsin area, while this carried only the waters of the Minnesota area, the two uniting then, as now, at or near Hastings. The sculpturing of the rocks into canyons in the western portion of Wisconsin, and their uniform trend southwestwardly show they must always have reached either the ocean or a great river, lying in that direction. Isolated areas of the Trenton in northwestern Wisconsin, as well as in central Minnesota, left to the present without destruction, though surrounded by larger areas of older formations deeply cut by the same forces into gorges and wide valleys, point directly to the close of the Lower Silurian as the starting point of the history of this part of the Mississippi valley. The rest of the valley-gorge, even to the Gulf of Mexico, being composed of much later formations, must have been unformed, even buried in the slowly accumulating sediments of the ocean for many ages later. If some portions of it are wider, or deeper, than this, it is due to greater volume of water, and to softer rocks, not to greater age. It is probable, then, that the advent of the first glacial period did not divert the Mississippi river from its channel below St. Paul. But the valley is much narrower above St. Paul than it is below, and this continues indefinitely southwestwardly by way of the Minnesota valley. This is very noticeable on examining the geological map accompanying this report. There is also a significant change in the direction, and one the more significant as it seems not to have been due to any rock formation existing at St. Paul, but directly contrary to the rock sculpturing that exists there favorable to the continuance of the river in any preoccupied valley running in the same direction. Allusion has been made to a possible ancient gorge through the Trenton north of St. Paul in describing the surface features of the county, but in the geological map of the county no such gorge is represented, because it never has actually been discovered, and its hypothetical location would perhaps be of no service.

These anomalous and significant facts can all be reasonably explained on the supposition that the Mississippi river was diverted from its ancient valley-gorge, north of St. Paul by the ice and drift of the first glacial epoch, and that it was driven into that which has been described in the report on Hennepin county, toward the west further, and joined the Minnesota valley at some point above Fort Snelling, but between that point and Shakopee, without passing over or through the Trenton limestone at all. Their united waters then formed the river which excavated the gorge between Fort Snelling and St. Paul (unless the Minnesota alone had already done it) between the first and second glacial epochs.

When the second glacial epoch came on, the country must have been more or less covered with constant or periodical ice sheets for many miles south of the line limiting actual glacier movement. These minor local and seasonal ice-areas produced their subordinate effects, but so similar to those of the great moving glacier itself that it is rendered very difficult, except with the aid of certain marked differences in the nature of the transported material, or some fortunate topographical or other evidence, to define the area of the second great glacier as compared with that of the first. These local ice-areas, which could not have had much movement as ice, served to disturb the surface of the old drift, and, by the water they afforded on breaking up periodically, to carry away the clayey parts, and to mix superficially the materials of the new drift with the old. At points, like that of Hennepin and Ramsey counties, where a great river course co-operates to mix these materials, we would necessarily see the new extending farthest over the old, and even the effects of ice in large masses extending down the valleys further than on the uplands.

In Hennepin county, and generally over the northwestern part of the State, are evidences that the ice of the second glacial epoch moved rather from the northwest than from the northeast. (See Hennepin county report, 1876.) The washed surface of the old drift, and the area of the loess-loam, both indicate that Ramsey county and the southeastern part of Hennepin were not disturbed generally by the glacial ice of this epoch. The disturbance, however, was sufficient to choke up again the Mississippi river, and at the mouth of Bassett's creek in Minneapolis, to drive it to the east, as fully detailed in the report on Hennepin county, thus bringing it into the channel that it now occupies between Bassett's creek and Fort Snelling.

The drift of the second glacial epoch is found as a stony clay in few places in Ramsey county. In some of the excavations at St. Paul, in the lower portions of the city, a gray hardpan is found, and there may be a considerable of it even under the water of the river itself, filling a deep gorge, but it lies over the red hardpan when that also is present. The disintegration and wash from the shales of the Upper Trenton seems also to have mixed with the drift at St. Paul so abundantly as to produce a stony gray clay which is hardly distinguishable from the true glacial clay. Some parts of Reserve township also show patches of the gray hardpan, rather mixed with than overlying the red.

As a gravel or course sand, the product of the second glacial epoch is much more abundant in Ramsey county. The gray gravel and sand, with the washed limestone pieces and boulders composing the bluffs and hills that have been so much excavated for streets at St. Paul, are the modified product of the second glacial epoch, modified at the time of their origin and deposition by the water resulting from the disintegrating margin of the glacier (perhaps here feebly extended to this point) but augmented by the co-operation of the natural waters of the Mississippi, then swollen to great dimensions. The same deposit, but much less abundant, produced by the same agency (except the presence of the Mississippi) is spread over much of Reserve or Rose townships, and has already been alluded to as the indirect effect of the second glacial epoch over the pre-existing drift surfaces.

Occasional pieces of northern limestone are found in the drift ridges and knolls about Mudhole and Fitzhugh and Gervais lakes, and two pieces of native copper were found on the south side of White Bear lake, near the Ramsey county line. Indistinct glacial marks in West St. Paul, under the red hardpan, run W. N. W.; but this was an unsatisfactory observation.

The Loess Loam.

That this deposit is the result of widespread diffusion of fresh water, at the time of the last glacial epoch, over those surfaces either drift-covered or not, which were not at the time affected by the glacier movement, is highly probable; but what the peculiar circumstances and causes of such gentle diffusion of nearly tranquil waters were, it is not yet possible satisfactorily to detail. The loess loam is found in all parts of Ramsey county, but it varies in thickness and in composition. It is thin or wholly wanting in some rolling gravelly tracts, and is very thick in some confined valleys. It is sandy, or graduates downward into sand, in much of the northern part of the county, particularly in Rice Creek valley, and in some places in the bluffs of the Mississippi below St. Paul, and it is fine and somewhat clayey in the high and rolling clay tract in the eastern part of the county, particularly in the eastern part of New Canada. It forms a very fine soil for farm crops. It covers the boulders and gravelly clay of the real drift. It fills some old valleys —indeed is always thicker in valleys than on the uplands. It is occasionally stratified and passes into sand below in places where agitated water was abundant enough to have moved such materials before the epoch of the loam. In other cases it is placed abruptly immediately over a coarse, gravelly or boulder-bearing stratum.

In the southwestern corner of the state (Rock and Pipestone counties) there is a gradual change from stony boulder-clay to the loess loam, horizontally, in passing from the Coteau de Prairie (in Lyon and Murray counties) southward to the Iowa state line. Exposures along the banks of creeks, and the digging of wells, make this plain. There is a gradual loss of boulders, then of the small stones, then of gravel; and an equally gradual increase of the characteristic features of the loess-loam,—close, clayey consistency, crumbling in the air like slacking quicklime, and white limy concretions. In some cases the concretions, which have been so often mentioned as a peculiarity of the loess-loam, are in the same deposit with small gravel stones of northern origin; and pieces of northern limestone. The drift clay, true northern boulder clay, the product of glaciers, thus changes gradually into a true loess-loam, the product of aqueous agencies. While this indicates for that locality, at least, a merging of one force into the other, and the slowness of the change, through an interval of about 50 miles in a broad, level, open country, it perhaps gives the key to the events that occurred in other latitudes where the surface was more broken, and where the effects are more complicated by not having all the steps recorded. Just as in the older geological formations, wherever the series is complete, without sudden transitions, the history is best known, so in the history of the drift, where the effects change gradually, are the records of "lost" epochs, and these "beds of transition" need the closest scrutiny, being the only evidence of what transpired between formations which in other regions pass abruptly from one to the other. This here indicates that the age of the loess-loam was cotemporary with that of the boulder clay in the Coteau de Prairie. There must be some explanation given for the co-existence of these forces which spread the loam and those which brought the glacial drift. In other words, if the loam, which is sometimes a laminated clay, be regarded as the equivalent in age of the fine laminated clays of the great lakes and of other high-water marks in the northwest, which have been referred to a distinct "epoch" by Dana and others (the Champlain), then that epoch was not subsequent in time to the glacial epoch but cotemporary with it, and its phenomena differ from those of the last glacial epoch because they have been studied at distant points where they are contrasted, and where the glacial winter operated differently. Where there is an immediate succession of superposition, that fact in the drift does not imply immediate succession in time any more than it does in the Silurian rocks, a fact which has been ignored many times; and hence have resulted a great many special histories and theories. The loess-loam, for instance, lies on the older drift clay all along the Mississippi valley, and has generally been taken to prove an immediate transition from the drift-epoch to the loam-epoch, when really a long period of time, involving forest growths and the slow on-coming of a glacial epoch, intervened, the loam itself passing horizontally into the glacial deposits of that epoch.

So in Ramsey county the loam has been seen to follow by insensible gradations from a sand or even a fine gravel, the change here taking place perpendicularly. In this case the coarser deposit below was the result of more copious and more agitated water, as in the bluff-terraces below St. Paul, or in the washed materials in the western part of Reserve township, and the loam the result of the diminution and more quiet state of the same waters. Thus, if the waters which overspread and washed the old drift and formed the gravelly terraces of the Mississippi came from the ice-fields of a contemporary glacier lying further north. then the waters which spread the loam, a finer deposit, also came from the same source, operating a little later, and with diminished force.

Wells in Ramsey County.

Good water for all household purposes is obtained in Ramsey county with little effort, in shallow wells that seldom pass through the drift, the majority of them being less than twenty-five feet deep. Throughout the northern portion of the county water is generally found in sand, or below a sandy loam, which also rises to the surface forming the soil and subsoil. The underlying clay is seldom penetrated to any great depth. But in the southern portion wells more frequently are deeper, and obtain water in gravel after passing through not only the surface loam but also a greater or less amount of red clay.

Material Resources—Timber.

The county is generally clothed with a scant forest growth, but the trees are small. There is not much timber of any sort suitable for lumber, and it is not much cut for fuel. Farmers cut some and haul it to St. Paul, but the wood fuel of St. Paul is very largely supplied from the "Big Woods," west of the Mississippi river.

The county has generally a good soil, the most of which still lies in its primeval condition. So far as the natural resources of the county are concerned, they lie in its soil to a greater extent than in any thing else.

Building Stone.

The stratum of the Lower Trenton used at St. Paul is the same as at Minneapolis, and furnishes a stone similar in all respects. The stone for the piers of the bridge over the Mississippi was taken out in West St. Paul, but about half a mile above the bridge.

The quarries in West St. Paul are in the public street, and are worked by Adam Rowe.

On the other side of the river, Mr. Sigler has quarries in operation on Stewart Avenue, near Leech street. The most important quarries in St. Paul are near the State Capitol, but there are a great many other small openings in different parts of the city.

Although this formation has been used in the majority of the stone buildings in St. Paul, and makes a fine appearance, yet its tendency to disintegrate has caused it to be less regarded, and has led to the introduction of other building stone. The U. S. Custom House is built of Sauk Rapids granite, and the Baptist Church of the Shakopee limestone quarried at Kasota.

Along the south side of White Bear lake, Sec. 32, Grant, Washington county, are exposures of the Trenton, some of which have been opened by Messrs. Walter and Weaver. Another is on the land of Mr. Huffman on Sec. 30, nearer the lake, in the bluffs facing northeast; and still others are further south and east. There is every reason for expecting as good building stone here as at St. Paul, except that the beds would naturally be a little more shaly, being situated nearer the ancient shore line when the deposit was forming, and for the same reason that makes the Trenton at St. Paul more shaly than at Faribault. These exposures, however, have not been much worked, and do not seem to be generally known.

Mills and Water-Powers.

The *St. Paul Mills*, St. Paul, are owned by Henry Shaber, and are on Phalen's creek. They have three run of stone for flour and one for feed. Have 20 feet fall of water, and turbine wheel. Only grind for custom use.

The *Brainerd Mills*, (Thau and Ham), have three runs for flour and one for feed, and are also in Phalen's creek, with 30 feet fall and turbine ; custom and shipping.

The *City Mills*, (Lownsman, owner) St. Paul, have two runs of stone for flour, and 19 feet fall ; custom only.

The *North Star Mills* are also at St. Paul, and have three runs of stone for custom work, and 19 feet fall, owned by Protz and Braun.

The *Union Mills* are owned by W. Lindeke, with four run of stone, and 20 feet fall, situated at St. Paul.

The last three above are run by overshot water-wheels.

The *Reserve Mill* are on the Fort Snelling road, at St. Paul, and are only calculated for grinding feed ; have two runs of stone and 20 or 21 feet fall ; owned by — Cunrad. These mills used to do flouring.

Brick in Ramsey County.

John Jæger, St. Paul, on Dayton's bluff, makes red brick from the loess loam.

Graham & Co., W. St. Paul, make red brick from clay taken from the alluvium of the flood plain. This yard, however, is now inactive, and is owned by John Jæger.

Section 32, White Bear. Formerly a good red brick was manufactured at a point between the railroad and the lake shore (Vadnais lake), from the surface loam that here covers the country, but as the owners were not much patronized, owing to the general financial depression which retarded all building, the yard was closed, and remains so.

The brick clay which is seen in the bluffs at St. Paul, in the excavations made for street purposes on Fifth street, between Sibley and Wacouta, lies between deposits of coarse gravel and stones, all water-washed. This clay, which is probably the near equivalent in age and nature of the brick clay so extensively used for brick at Minneapolis and Carver, has not been thus employed at St. Paul.

Earthworks.

On Dayton's Bluff are several large mounds, one being about six feet high and 30 or 40 feet across.

At White Bear Lake is a large artificial mound, about 12 feet high and 35 or 40 feet across. It is close to the shore of the lake, within the village, on lot 2, on the road to Goose Lake.

In Dayton's bluff, on P. Kelly's place, is a covered cave in the white sandstone, not far from Carver's cave, in which is a deposit of clay containing lumps, and some large pieces, of what goes by the local name of "kaolin." It is purely white, tasteless, and gritless, and seems to be the same as the white veinings found in the lacustrine clay of the Red river valley. This clay is said to completely fill the cave, which was discovered in digging to make room for a house and barn in the lower part of the bluff. The clay resembles that seen at Mankato in the nooks of the Shakopee rocks, as described in the Second Annual Report, but it has not been possible to give it, nor the cave, any satisfactory examination. It is probably of the nature of Carver's cave itself; and they should both be carefully examined for traces of ancient habitation.

In another part of the Annual Report for 1877 will be found further account of early man in Ramsey county, and illustrations of some implements found in St. Paul.

The survey of Ramsey county was facilitated by the active interest and guidance of Hon. C. S. Bryant, of St. Paul.

VI.

THE GEOLOGY OF ROCK AND PIPESTONE COUNTIES.

Situation and Area.

These counties form a rectangle running north and south, in the very southwestern corner of the State, and border on Iowa and Dakota. They have a width of a little more than three government towns, and each a length of four.

Surveying Statistics of Rock County.

BY F. E. SNOW.

Township.	Range.	TOWNSHIP LINES.		SUBDIVISIONS.	Acres.
		When Surveyed.		When Surveyed.	
101	44	S.	August 1852	September 1869	23,035.46
...	..	N. E. W.	July, August 1867	...	...
102	44	N. E. S. W	July, August 1867	September 1869	22,929.55
103	44	N. E. S. W	July, August 1867	September 1869	23,078.93
104	44	N.	September 1858	October 1869	23,081.10
...	..	S. E. W.	July, August 1867	...	...
101	45	S.	July 1852	November 1869	22,948.32
...	..	W.	September 1858	...	...
...	..	N. E.	July, August 1867	...	...
102	45	W.	September 1858	November 1869	22,941.68
...	..	N. E. S.	July, August 1867	...	...
103	45	W.	September 1858	October 1870	22,997.45
...	..	N. E. S.	July, August 1867	...	...
104	45	W. N.	September 1858	October 1870	22,974.94
...	..	E. S.	July, August 1867	...	...
101	46	S.	July 1852	September 1870	23,048.40
...	..	E.	September 1858	...	...
...	..	N. W.	September 1867	...	...
102	46	E.	September 1858	September 1870	23,072.24
...	..	N. W. S.	September 1867	...	...
103	46	E.	September 1858	Sept., Oct. 1870	23,038.05
...	..	N. W. S.	September 1867	...	...
104	46	E.	September 1858	July 1871	23,100.92
...	..	N.	September 1861	...	...
...	..	S. W.	September 1867	...	...
101	47	S.	July 1852	September 1870	7,928.52
...	..	W.	July 1859	...	...
...	..	N. E.	September 1867	...	...
102	47	W.	July 1859	September 1870	7,889.56
...	..	N. E. S.	September 1867	...	...
103	47	W.	July 1859	September 1870	7,862.81
...	..	N. E. S.	September 1867	...	...
104	47	W.	July 1859	July 1871	7,788,18
...	..	N.	September 1861	...	...
...	..	E. S.	September 1867	...	...
			Total	number of acres	307,716.11

Surveying Statistics of Pipestone County.

BY F. E. SNOW.

Township.	Range.	TOWNSHIP LINES.		SUBDIVISION.	Acres.
		When Surveyed.		When Surveyed.	
105	44	S.	September......1858	August......1867	23,006.06
...	..	N. E. W.	July, August....1861		
106	44	N. E. S. W.	July, August....1861	August......1867	23,064.09
107	44	N. E. S. W.	July, August... 1861	Aug., Sept...1867	22,998.97
108	44	N.	September......1858	September...1867	22,885.66
...	..	E. S. W.	July, August....1861		
105	45	S. W.	September......1858	September...1867	23,434.99
...	..	N. E.	July, August....1861		
106	45	W.	September......1858	September...1870	23,451.93
...	..	N. E. S.	July, August....1861		
107	45	W.	September......1858	September...1870	23,527.78
...	..	N. E. S.	July, August....1861		
108	45	N. W.	September......1858	July.........1871	23,468.29
...	..	E. S.	July, August ...1861		
105	46	E.	September......1858	July.........1871	23,048.16
...	..	S.	September. 1861		
...	..	N.	September......1870		
...	..	W.	July............1871		
106	46	E.	September......1858	Sept., Oct...1870	23,001.83
...	..	N. W. S.	September......1870		
107	46	E.	September......1858	October.....1870	23,044.78
...	..	N. W. S.	September......1870		
108	46	E.	September......1858	July.........1871	22,959.70
...	..	N.	September......1861		
...	..	S.	September......1870		
...	..	W.	July............1871		
105	47	W.	July............1859	July.........1871	4,852.06
...	..	S.	September......1861		
...	..	N.	September......1870		
...	..	E.	July............1871		
106	47	W.	July............1859	October.....1870	4,783.90
...	..	N. E. S.	September......1870		
107	47	W.	July............1859	October.....1870	4,771.48
...	..	N. E. S.	September......1870		
108	47	W.	July............1859	July.........1871	4.588.07
...	..	N.	September......1861		
...	..	S.	September......1870		
...	..	E.	July............1871		
			Total	number of acres	296,887.75

Natural Drainage.

The drainage is toward the south and southwest, and finally enters the Missouri river near Sioux City, in Iowa, being the only water from the State of Minnesota that takes that route to the Gulf of Mexico. The main stream is Rock river, which flows almost due south, receiving several tributaries from the east, but none that are important from the west. Other streams rise west of Rock river, having their headwaters near that stream, but flow westward, leaving the State, and finally reaching Big Sioux river. These latter are the Flandrau, Pipestone, Splitrock and Beaver creeks.

These streams are all small, and in the summer time some are rather valleys where gathers a little water, than living streams. They furnish no water-powers that have been improved, as yet, though without doubt, some parts of Rock river would furnish sufficient fall for milling by a little artificial aid.

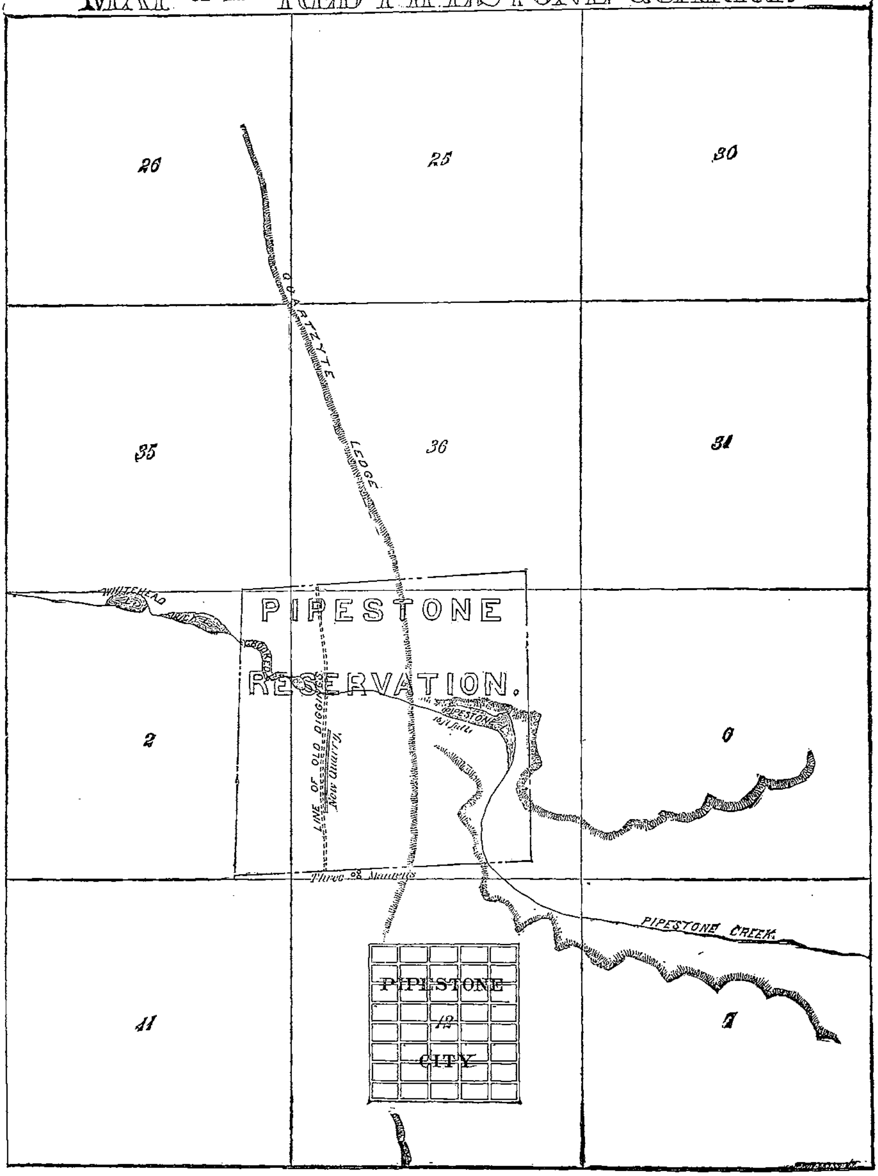
Surface Features.

These are emphatically prairie counties, and are nearly level over large tracts. They are undulating in their eastern portions, due to the existence of more numerous streams whose valleys lie rather deeply below the general level. Along the valley of Rock river and its tributaries is the greatest diversity seen in these counties, and this is mainly confined to Rock county, though the high peninsula between Rock river and Chanaranbie creek in the southeastern part of Pipestone is a prominent object in the horizon for many miles.

Rock river valley is about a mile or a mile and a half wide. The immediate banks are from six to ten feet above the water, and are composed of gravel, which is sometimes coarse, and is very largely made up of limestone. The outer banks are from fifty to seventy-five feet higher, and on the eastern side are more stony with foreign boulders than on the west, a circumstance, however, which may be owing to the action of the prevailing western winds, which would uncover and keep bare the coarser materials of the surface by blowing away the sand and clay during the dry and windy months of the year, while the bluffs on the west side would not only not receive such winds, but would serve to collect all particles flying toward the east from the prairie above.

The range of high rocky land running northwest from Mound, near Lu Verne, is a conspicuous object in the horizon from the north and east, and looks like the Coteau from Marshall. The highest point is where it breaks off squarely to the valley of Rock river, and

MAP OF THE RED PIPESTONE QUARRY.



is distinctively known as "The Mound." There is no rock south or east of that, except occasional boulders, which are common along the drift bluffs of Kanaranza creek.

The country northeast from Lu Verne, along the Champepedan creek, and toward the "Lost Timber" (Sec. 2. T. 105, R. 43 W.) is in general, a fine undulating prairie, the subsoil being a yellowish, gravelly and stony clay, with rarely a visible boulder.

The bluffs of Chanaranbie creek and Rock river, in Pipestone county, are abrupt and from 75 to 100 feet high, composed of drift. There are here a great many short, sharp ravines, branching from these valleys, cut deeply, like the ravines in the bad lands of Montana. The flat bottom lands support a heavy growth of grass.

Beaver creek valley is broad, with changing rolling bluffs, about half a mile wide, with no terraces. The low land is cultivable, but little water being in the valley. The upland is also undulating or rolling, a prairie, with no shrubs nor trees, nor stones. The soil is the loam, which becomes more and more like the loess loam of the Missouri, toward the south, while toward the north it is more gravelly and stony. Along Beaver creek the stones are very scarce, but they do occur along the brows of knolls, and are struck in digging wells, even in this loam.

Pipestone county is more uniformly a smooth prairie than Rock, and is marked by long ridges or swells, corresponding to the low water-sheds running north and south. The subsoil of this county is nearly everywhere a gravelly or stony clay, but becomes finer toward the surface, and in the soil it is rare to see a northern boulder.

There are but few settlers in Pipestone county, and Rock county has but lately been occupied. Pipestone city is a "paper town" and has three houses, one of which is occupied and accommodates the only post-office in the county; but it is on the line of the probable extension of the Southern Minnesota railroad. Land in both counties is rapidly being taken both by settlement and purchase, the new settlers being generally farmers from the eastern part of Minnesota or from further east.

THE GEOLOGICAL STRUCTURE.

The only known bedded rock in these counties is a red quartzyte, probably the equivalent of the New York *Potsdam Sandstone*, but which Dr. C. A. White, of the Iowa survey, has designated the *Sioux Quartzyte*, as it is seen to outcrop in the extreme northwestern corner of Iowa. Of this the largest exposures are in Rock county, but the best known is at the famous "Pipstone Quarry," near the center of Pipestone county.

As this locality has become somewhat famous on account of the extensive use made of the red pipestone by the Indians, and the difference of opinion expressed by scientists as to its origin and age, the following *resume* will be of interest:

The first written account of the quarry was by George Catlin, found in the 38th volume of the First Series of the American Journal of Science and Arts, p. 138, in a letter addressed to Dr. C. T. Jackson, to whom he also sent a sample of the pipestone for analysis. The journey was made on horseback from the falls of St. Anthony, in the summer of 1836, in company with "a young gentleman from England, of fine taste and education," and a single Indian guide. Mr. Catlin describes the quarry as "on the very top" of the Coteau des Prairies which rises above the country about it with graceful and almost imperceptible swells. The quartzyte he regards "a secondary or sedimentary deposit," but no further defines its supposed age.

Jean N. Nicollet visited the quarry in July 1838, as is plainly shown bv his own name and date for that year, together with the initials of his companions, boldly and artistically cut on the quartzyte, at the top of the ledge, near the "Leaping Rock," and a little north of where the creek passes over the brow of the escarpment. His "Report, intended to illustrate a Map of the Hydrographical Basin of the Upper Mississippi river," is "Document 237," of the second session of the 26th Congress, ordered printed Feb., 1841. He gives no opinion of the age of the rock, but quotes Dr. Jackson's analysis of the pipestone, or *Catlinite*, as it was named by Jackson. "As a mineralogical species it may be described as follows: compact; structure slaty; receiving a dull polish; having a red streak; color blood red, with dots of a fainter shade of the same color; fracture rough: sectile; feel somewhat greasy; hardness not yielding to the nail; not scratched by selenite, but easily by calcreous spar; specific gravity 2.90. The acids have no action upon it; before the blowpipe it is infusible *per se*, but with borax gives a green glass," While Prof. Jackson assimilates it to *agalmatolite* (*pinite* of Dana) Nicollet regarded it as differing very materially from it in general aspect, its conduct before the blowpipe, and its total insolubility in sulphuric acid.

Prof. James Hall, next in chronological order, read a paper before the *American Philosophical Society* in June, 1866, in which, among notes on the geology of some of the western portions of Minnesota, he classes the red quartzite as Huronian. He imagines the Coteau des Prairies caused by a vast synclinal in the rocks of this age. He did not see the pipestone quarry itself, having only gone to Lake

Shetek, where he describes a wall of rock which he thinks the same in age. His examinations were made in 1865. His is the first attempt to fix the age of this rock.

Dr. F. V. Hayden visited and examined the locality in October, 1866, and his account is in the *American Journal of Science and Arts* for January, 1867. After examining rock of the same kind on the James and Vermilion rivers, in Dakota, and at Sioux Falls, on the Big Sioux river, he gives an interesting detailed description of the quarry, and inclines to the opinion that the quartzyte is supra-carboniferous, Triassic perhaps, or an extension downward of Cretaceous No. 1.

Dr. C. A. White has given a description of a "Trip to the Great Red Pipestone Quarry," in the *American Naturalist* for 1868-9, but he does not there state anything concerning the age of these rocks, though elsewhere, he has ranked them as pre-Silurian, and named the formation the "Sioux Quartzyte." (Geology of Iowa, 1870).

The reader is further referred to the first and second Annual Reports for reasons for believing this formation to be the equivalent of the Potsdam sandstone of New York.

The known area of this rock in Rock and Pipestone counties is approximately marked out on the accompanying map, but there is much probability of its being much greater, and perhaps to include the greater portion of both counties. The Cretaceous formation, no doubt, also occurs in the northern part of Pipestone county, and overlies unconformably the quartzyte in other places, but it has not been seen. Dr. Hayden has mentioned such facts in his account of the geology of southwestern Dakota, occurring at or near the mouth of Firesteel creek, on the James river.

At the Red Pipestone quarry there is a ledge of rock which runs north and south nearly three miles. This ledge of rock consists of layers of red quartzyte that have a dip of fifteen or twenty degrees toward the east, so that the rock soon disappears under the prairie in that direction, but presents a nearly perpendicular escarpment toward the west, formed by the broken off heavy layers of the rock; though its greatest hight, which is not more than 25 feet, is a little north of the present pipestone quarry. It also gradually disappears under the prairie both toward the north and toward the south, the lower ground on the west of the escarpment slowly rising, in those directions like the sides of a basin, and coalescing with that on the east of the ledge. A small stream, dry some parts of the year, known as Pipestone creek works northwestwardly and passes over the ledge from the upper prairie to the lower with a perpendicular fall of about 18 feet. In the vicinity of this fall, and also at one or two places further south, are dwarfed bur-oaks and shrubs, but the country in all directions for many miles is a prairie which has a great monotony of surface. It is not on the top of the Coteau de Prairie, as supposed by Catlin, that range of hills being 25 or 30 miles further northeast. Mr. Catlin seems to have correctly described the eastern ascent of the Coteau as rising with almost imperceptible swells above the prairies further east, but failed to observe when he passed down the western slopes, that the real Coteau dies out still more insensibly into the prairies on the western side. The Coteau passes nearly through the middle of Lyon county, the northeastern quarter of Murray, the southwestern part of Cottonwood, and leaves the state along the western side of the DesMoines river, in Jackson county, gradually becoming less noticeable. It is characterized by numerous lakes and gravelly drift hills. It is a vast glacial moraine, comparable to the ridges in northwestern Ohio, and the "Kettle Range" in Wisconsin, but is the most remarkable, as it is the most extended, glacial moraine known in the United States if not in the entire world. It runs along the east and north side of the Missouri river till it passes out of the United States into British America.

The little stream which crosses the rock at the pipestone quarry widens out into a lake just before passing the ledge, making Pipestone lake, and again after passing it, it forms Crooked, Duck and Whitehead lakes in the same way. In these lakes water stands constantly.

The rock itself in general is exceedingly hard, in heavy layers of one foot, or of two or three feet, and is separated by jointage planes into huge blocks of angular shapes that lie often somewhat displaced or even thrown over entirely by the action of the frost through many winters. Thus, there is a rough talus along the foot of the escarpment where grow a few bushes and small oaks, protected from the prairie fires by surrounding masses of fallen quartzyte. The rock is sometimes pinkish and massive; when blood-red it is more apt to be thin-bedded.

The real "pipestone quarry" is situated about a quarter of a mile west of this ledge and in the low land of the lower prairie. Earlier diggings seem to have been opened in the superficial outcroping of the pipestone layer, and to have followed along its strike north and south nearly a mile, without penetrating very deeply into the rock. The layer which furnishes the pipestone is about 18 inches thick, and is embraced between heavy layers of the same rock as the ledge already described, and they all dip together toward the east, and of course run under the main escarpment. The present quarrying is a little east of the line of old diggings, but follows along the strike of the formation the same as the other, the only difference being in having greater depth (the pipestone layer is about 6 feet under the ground here) and in the difficulties encountered in removing about five feet of very firm, pinkish quartzyte in heavy beds.

The Catlinite itself is a fine clay varying in color from blood-red to pale red, or pinkish, or even to a pale yellowish red. The lighter colors fade into the darker, but sometimes the light appears in the red as round spots, on a polished surface, but the red is not thus distributed through the lighter shades. It has, of course, suffered all the metamorphic influences that the quartzyte itself has, but it has not lost its distinctly bedded structure, which may be seen when examined microscopically in polished thin sections. Indeed it seems to have a laminated structure ; and the different shades of color appear sometimes to be due to openings and fissures produced in the red clay and becoming filled with sediment of a lighter color. It seems to be made up of little grains of quartz having an abundant cement of red ferric oxide, the alumina present (as indicated by chemical analyses) being mixed rather with the latter than combined with the former.

Prof. Peckham, who has analyzed for the survey samples of the red and of the pale red pipestone, makes the following report :

Prof. N. H. Winchell :

MY DEAR SIR—I have the pleasure to report the following analyses of serial numbers 52 and 53 :

No. 52—Pale Catlinite.

Silicic oxide	SiO_2	58.25	per cent.
Aluminum oxide	Al_2O_3	35.90	"
Water	H_2O	6.48	"
Total		100.63	

The aluminum oxide is a trifle too high and contained a trace of iron (Fe_2O_3.) This specimen did not contain an appreciable amount of either lime or magnesia.

No. 53—Red Catlinite.

Silicic oxide	SiO_2	57.43	per cent.
Aluminum oxide	Al_2O_3	25.94	"
Ferric oxide	Fe_2O_3	8.70	"
Water	H_2O	7.44	"
Total		99.51	

This specimen contained in addition a trace of both lime and magnesia.

A comparison of these results with those given in Dana's Mineralogy, ed. 1870, confirms the statement there made that Catlinite is a rock and not a mineral. The substance appears to be an indurated or partially metamorphosed clay containing a variable amount of ferric oxide and water.

An analysis by the late Dr. Jackson, of Boston, (Am. Jour. Sci., I. xxxv., 388) gives the following in 100 grains:

Water	8.40
Silica	48.20
Alumina	28.20
Magnesia	6.00
Per-ox. iron	5.00
Ox. Manganese	.60
Carb. lime	2.60
Loss (probably magnesia)	1.00
Total	100.00

These results indicate a considerable amount of earthy carbonates and when compared with those given above show that the rock is quite variable in composition. Neither of the specimens analyzed by myself was of the spotted or mottled variety, which *may* account for the presence of the earthy carbonates in the analysis by Dr. Jackson.

The red variety was found to be much more difficult to decompose by fusion with alkaline carbonates than the average silicates. It was found necessary not only to reduce it to an impalpable powder but to prolong the fusion to from eight to ten hours to insure complete decomposition.

Respectfully submitted,

S. F. PECKHAM,

MINNEAPOLIS, MINN., May 20, 1878. *State Chemist.*

Southward from the region of the Pipestone quarry the land continues high, and in some instances there are ridges, or long knolls, of drift, that are broad and evenly rounded over by a thin loam. The first exposure of the rock, in the vicinity of the road to Lu Verne, is on Sec. 13, T. 105, R. 46, along the south side of the valley that crosses westwardly near the centre of the section. It extends about a mile east and west. It here is seen to form an undulating floor on which the loam is thinly spread. It is hard, massive, pinkish-colored and superficially vitrified, in some places also showing two directions of glacial striæ, one being by compass nearly N. and S. and the other S. 52 deg. E.

The same line of rocky outcrop extends westwardly to the Splitrock creek, and along that creek and its eastern tributaries as far as it continues in the State. It seems to have a changeable dip, but nowhere presents perpendicular bluffs.

Two and a half miles further south on N. E. ¼ Sec. 36, is another exposure of the same rock, along a similar shallow ravine making westward—and again about half a mile further south on the high prairie.

At a point about ten miles north of Lu Verne this rock becomes frequently exposed both in the valleys and on the hills and continues so to the Mound, near Lu Verne, when it suddenly breaks off along the west side of Rock river, and is not known to the south of that place. Throughout this distance it forms a high plateau three or four miles wide and about a hundred feet higher than the prairies east or west, but the surface, though frequently rocky, is not rough. It is undulating ; and the plateau sinks gradually down tothe level of the rest of the country on either side. This plateau terminates abruptly in a rocky and precipitous bluff facing southeastward, three miles north of Lu Verne in what is known as "The Mound." There is a very large rocky outcrop in Secs. 4, 5, 6, 7 and 8, T. 103 N., R. 45 W. There are less frequent exposures in Gregory township, and the town next west. The Splitrock creek which crosses the northwest corner of Rock county has frequent exposures both in Rock and Pipestone ; but in Pipestone the rock range veers toward the east, into the centre of T. 104. R. 46 W., and disappears till reaching the region of the Pipestone quarry. In the N. W. part of Mound township the rock dips N. W. with a thrown, or twist, which, by slightly changing it, brings it soon below the surface. Indeed there seems to be a succession of ridges or swells, with changeable dip, though the most observable is to the northwest, about 10 degrees. These ridges are not covered with gravel or sand like similar ridges already mentioned east of the Coteau, under the operation of glacial forces, (ice and water) but while they occupy the grand divide of the county, they are nearly bare, on their tops and along their slopes, or are thinly covered with a gravelly loess loam, while the drift, even the stony clay that has been largely attributed to ice, occupies the valleys between to the thickness of at least 30 or 40 feet. On the top of some of these ridges, apparently near the top of this formation, the rock is conglomeritic. This occurs in large superficial areas, planed and smoothed down (rarely glaciated) and the colors of the pebbles, usually not larger than beans, give these spots a blotched and variegated mottling. The pebbles are mainly white, but some are jasper-red and some purple.

All over these ridges, which vary from a quarter of a mile to three or four miles in length, and are for the most part thinly covered with soil and turf, there are little nests of large blocks of quarzyte piled so together that they seem to have been thrust up from below by some force. The edges of these blocks are squarely broken off, and slope toward each other, *i. e.,* toward the centre of the pile, while the blocks themselves lie so that their upper surfaces slope in all directions away from the center. Similar upheaved spots occur on the red quartzyte outcrop near New Ulm, and were described in the report for 1873. They were then attributed hypothetically to recent igneous forces. These upheaved spots vary from five to fifteen feet in diameter, or perhaps more. They may have been caused by ice, *i. e.*, alternate freezing and thawing with the change of seasons, aided by the force of vegetation and a little soil gradually getting into the openings.

At "The Mound," where this high land terminates abruptly, and faces the valley of Rock river, the elevation is about 175 feet above the river. The perpendicular bluff of rock is from 40 to 60 feet in its highest part; but owing to a dip of about 20 degrees from the horizon, nearly west, or partly northwest, and to the breaking off of the upper layers causing a gradual slope from the brow of the hill backward through several rods, the actual thickness of beds visible may be 150 feet. The rock here also appears to be almost entirely a reddish or pink, heavy-bedded, quartzyte. If wrought there might be some softer and thinner layers discovered in the angles of the talus, but the refractory nature of the great mass of it will cause it to be used but sparsely for building. The main bluff curves westwardly at both ends, and by reason of the dip and ravines that enter the valley from the west, its exposed layers gradually disappear under the soil in that direction, and the rock is lost in the prairie.

Near the base of the bluff of perpendicular rock, on a slope which descends to the river, once probably covered by the water of the river, on some of the lowest beds, the rock has the general shape of glaciation, but there are no striæ, the surface showing rather the action of water. On the top of the bluff are glacial striæ running S. 20 deg. W. by compass. Ten miles northwest of Lu Verne such marks run N. and S.

The Drift.

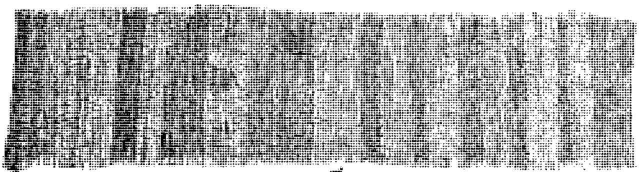
The most important fact in connection with the drift of these counties is a gradual transition, from north to south, from drift clay, with stones and boulders to loam clay that has all the characters of the well-known loess-loam of the Missouri valley. The northern part of Pipestone county lies not far from the Coteau du Prairie, which is a vast glacial noraine of drift materials, and is even affected somewhat in its contour by the westward decline of the Coteau to the prairie level. It is as characteristically a hardpan clay—the main mass of the drift, in this part of Pipestone county—as in any part of Minnesota. In traveling southward there is a gradual superficial change in all its characters. This change pervades at first but a small thickness of the deposit but by degrees involves the drift to the depth of 20 feet. At first there is a diminution in the number of visible boulders ; then a smoothness in the creek bluffs ; then a gravelly clay on the surface, fine and close ; then a closeness in the prairie soil ; then, in digging wells a few limy concretions are seen mingled with small gravelstones, and at last a fine, crumbling loam clay that cannot be distinguished from the loess loam, which extends to Sioux City in Iowa, and there *is known* as the loess-loam of the Missouri valley and has a thickness of several hundred feet. Wells dug in the southwestern part of Rock county demonstrate also a similar *perpendicular transition from loam to drift clay*, the former being true loess-loam and the latter true hardpan, or boulder clay. This appears like rank heterodoxy, but it is not a matter of opinion nor theory. It is the result of actual observation. The writer was as much surprised to find it as others will be to read it, and it appears almost inexplicable. The writer had abundant and favorable opportunity for observing this change in the grades and cuts of the new railroad from Lu Verne to the State line, and verified it in wells dug, and being dug, in that part of the county. In some places the loam passes below into a quicksand.

We have here then a series of changes by which, between the Coteau and Sioux City the loess-loam is produced from the drift hardpan, by the slow withdrawal of the stones and gravel, and the gradual predominance of water-action over ice-action, the Coteau being the limit of unmodified ice-action involving the whole drift sheet. It is not impossible that ice, in a broad sheet, underlay the surface, embracing the now underlying hardpan, while superficial waters disturbed and modified the surface of the drift for some distance south of the Coteau. Thus it seems that, by the agency of water very largely, a considerable tract of country was covered by drift which differs at first but slightly from the true hardpan, but at points more removed from the field of glacial action, becomes more and more clearly a water-deposit. This change could be observed only in a broad, level tract like southwestern Minnesota. This southward conversion of the stony and gravelly clay into the loess-loam must have been the result of copious drainage and wash from the northern drift, but a wash that seems to have been so gradual, and yet so profound in its effect, as to have embraced at once a great thickness of the drift materials, causing them to flow more like a pasty mud at first, than water, but finally becoming simply a muddy water. This process is perhaps what covered the extensive buried soils and vegetable remains in Fillmore and Mower counties, beyond the limits of the last ice-period, without wholly disrupting them, and perhaps will account for the same phenomenon in Ohio and Illinois. It seems evident that the vast moraines of the northwest, where, in similar topography, the changes witnessed in the drift must be due to changed climatic conditions, mark great epochs in the history of the ice-age. There are two such that cross Minnesota, the older being the Coteau, and the younger the Leaf Hills. Corresponding to the latter the Kettle Range in Wisconsin seems a parallel phenomenon. [See also the report on Ramsey county.]

There is evidence of glacier-action, or what has been recognized as evidence of glacier-action, in Rock county south of the Coteau. The quartzyte is polished, striated, and sculptured superficially on the tops of the ridges in the central part of the county as only glacier-ice is known to do. At the Pipestone quarry, (near "The Three Maidens") such marks run 22 deg. W. of S. by compass. On the strike of the ledge at the same place they ran S. 10 deg. E. varying to 20 deg. W. of S. On Sec. 13, T. 105, R. 46 W. they run in two directions, one direction being nearly N. and S. and the other S. 52 deg. E. within the valley of a little stream. On the rock near the top of the southern side of this valley, which is a slight, shallow depression, glacial marks runs S. 22 deg. W. This is but a few rods from the last observation above. At another point, about ten miles north of Lu Verne, glacial marks were observed running nearly N. and S. On the rock at "The Mound" they run S. 20 deg. W. by compass. It seems almost impossible that in so level and open a country, and on the same rocks, without apparent cause, the glacier which must have been hundreds of miles wide, if it existed here at all, could have taken so diverse directions in so short distances. It cannot be doubted, however, that this marking was done by a force that exerted a great pressure at the same time that the marks were made. This pressure is evinced not only in the marking itself, which is on the hardest formation found in the State, but in the innumerable checks and flaws that cover the surface where this rasping has taken place, and yet leave it in the main a smoothed and rounded or *stossed* surface. These checks run curvingly downward at varying angles with the surface, and to all depths less than an inch, but usually less than one-sixteenth of an inch, and indicate perhaps an incipient crushing to the depth of at least an inch. They show in what manner the rasping reduced the original projecting knobs. Where the natural seams or planes of jointage cross the rock, these little checks are larger, causing the quartzyte to chip off sooner and deeper with a curving and choncoidal fracture. This prevailing direction is transverse to the crushing force, so that the rock, along some grooves, has a short conchoidally laminated structure transverse to the grooves, penetrating it to the depth of a quarter to half an inch, exhibited now in a series of little curving furrows where the laminæ broke off successively, the concavities of the laminæ being toward the north.

FIG. 10.

N.



S.

Striated red quartzyte in Rock county.

This marking is represented in Fig. 10, but the figure does not show a great many fine checks with which the surface of the rock is nearly covered, but it shows correctly the prevailing direction of the curvature, and its relation to the moving force. This manner of glaciated marking is visible on Sec. 13, T. 105, R. 46, and also on "The Mound," near Lu Verne. It can be compared to a cross-grained planed board, where the plane has been driven against the grain, except that the cut edges are curved so as to present their concavity toward the cutting or planing force.

It has already been mentioned that there are but few boulders in Rock county. They are generally confined to the creek bluffs and valleys. Even on the plateau caused by the red quartzyte running from near Lu Verne northwestward they are not seen, or are so rare as to be noteworthy. This is an anomaly. In ice-covered regions, *i. e.* in regions known to have been last passed over by the ice of the drift epoch, there would be no place where foreign boulders would be found more thickly than on such rocky elevations.

In traveling over the plateau of quartzyte, about on Sec. 16, Mound, one large solitary granite boulder may be met with. It lies directly on the quartzyte. It is rough and granulated, and there is a circular excavation or concavity in the soil in which it lies. It is about ten feet long and five feet high, and has a groove horizontally circumscribing it about a foot in width and three or four inches deep. Taken altogether it immediately reminds the beholder, not less by its general shape than by this groove, of the *stone hammers* sometimes found. Its size precludes its being one, but its shape is very like them. The groove may have been formed by the action of ice and water on its sides, as it has the appearance of lying in ordinary seasons in a little lake of water, which at the time of this examination was entirely dried up. This boulder, like the "Three Maidens," at the Pipestone quarry, must be referred to the date of the boulder clay, and in that case it was not disturbed by, but probably witnessed, the spreading the loam which came later.

The "Three Maidens," and the three others, (smaller) that make up the cluster of six granite boulders lying just outside the Indian Reservation at the Pipestone quarry, also rest on the surface of the red quartzyte about 60 rods southeast of the quarry and at the foot of the long ledge or escarpment that passes north and south. They evidently once constituted one immense boulder and have become six from the falling apart, under the influence of frost, of the granite along its natural seams or joints. Such a separation of large boulders is sometimes seen on the prairies in Minnesota under circumstances which demonstrate their former entirety.

On the surface of the glaciated quartzyte about these boulders, which is kept clean by the rebound of the winds, are a great many hieroglyphic inscriptions, which were made by pecking out the rock with some sharp-pointed instrument. They are of different sizes and dates, the latter being evinced by their manner of crossing and interfering, also by a difference in the weight of the instrument used. They generally represent some animal, such as the turtle, wolf, bear, badger, buffalo, elk, and the human form. The "crane's-foot" is the most common. They are very similar to those represented on Plates XI and XII of Vol. II, of the "Bulletins of the U. S. Geol. and Geog. Sur. of the Territories," accompanying the article of W. H. Holmes on Ancient Ruins in Southwest Colorado. The Indians regard the "Three Maidens," represented by the three larger boulders, as the maids from whom the tribes sprung after the destructive anger of the Manitou had slain the people. It would seem as if any warrior or hunter who had been fortunate in the chase and happened to pass here, left his tribute of thanks to the Great Spirit in a rude representation of his game, and perhaps a figure of himself, on the rocks about these boulders. In some cases there is a connection of several figures by a continuous line, chipped in the surface of the rock in the same manner, as if some legend or adventure were narrated, but for the most part the figures are isolated. This is the "sacred ground" of the locality. There are hieroglyphics at no other place around here, though there is abundance of bare rock.

Common Wells in Rock County.

The water of wells in the loam, or in the drift-clay, is very hard. This is caused by a large amount of limestone gravel disseminated through all the materials of the drift, derived from the limestones of Winnipeg. There is occasionally a water which has a distinctly alkaline character, but this is not common. Nearly all the wells of the county are curbed with pine boards, and from that fact great numbers of them are contaminated with the organic decay known to result from that practice, and a number were examined that were very foul from that cause. Several recent cases of typhoid fever at Lu Verne are directly referable to that cause, and no doubt, if the facts could be known, many others in the country could be accounted for in the same way. The curbing of wells in the prairie regions with pine boards or planks is very common, owing to the lack of convenient stone, and the ease of constructing such curbs of wood; but it is a practice which all well-diggers should loudly and persistently protest against, and which all the owners of wells should discontinue, as it is a fruitful source of foul water, causing intestinal diseases and typhoid fevers. The adjoined table shows the depth and character of some of the wells of the county.

Wells in Rock County.

Owner's Name.	Location.	Depth—feet.	Remarks.
A. L. Marsh	S. W. ¼ Sec. 4, Lu Verne	33	Only seep water; water hard; "joint clay" all the way, more compact in the bottom.
—— Stone	Lu Verne	13(?)	Sandy loam, then loose stones, some large, 6 ft.; gravel 8 in.; pebbly clay 7 ft.; then blue clay.
—— Taylor	N.E. ¼ Sec. 10, Lu Verne	84	No water. Loamy sand, with stones; pebbly clay, becoming blue at 24 ft.; blue clay 15 ft.; fine, dry sand; a shell (described like a common fresh water clam) and wood were taken out at 52 feet in this sand, which is clayey when wet, and fine like flour when dry. (This may be the Cretaceous.)
W. O. Crawford	S. E. ¼ Sec. 20, Beaver Creek	28½	Abundant good water in quicksand; in "the lower edge" of the stony blue clay, twenty feet below the surface, a stick with grain like elm was taken out.
—— Kennedy	N.W. ¼ Sec. 35, Lu Verne	42	Poor water; a dangerous gas gathers in this well; cedarwood found at 38 feet.
—— Taylor	N.E. ¼ Sec. 10, Lu Verne	12	Loam; gravel; "fine dry sand," which sparkles in the sun; this sand is so fine as to be water-tight, and to make a reservoir for water, and may be of the Cretaceous.
Peter Webber	S.W. ¼ Sec 8, Lu Verne	42	At first no water, but afterward filled to within 10 feet of the top with a poor (alkaline) water; "joint clay" all the way, with crystals of gypsum.
Worthington & Sioux Falls R.R.	Sec. 17. Lu Verne	15	"Joint clay"; loose stones and gravel with water; "red clay" below the gravel.
Samuel Spalding	Sec. 20, Lu Verne	28½	"Joint clay or red clay"; then blue clay; water from a sand vein in "joint clay."
—— Shively	Kanaranza	22	Good water from sand at 18 feet, under "joint clay."
Henry Halbut	Magnolia	30	Seep water, good; "joint clay" all the way.
E. Sheldon	Beaver Creek	18	This is in the general valley of Beaver Creek, between two ravines; good water; six feet sandy loam; six feet stones and gravel; two feet shells and sand (these shells were Unio and were soft and rotten); two feet blue clay, containing wood.
Lary McDermott	Mound	25	Good water; struck the rock under gravel and sand.
Samuel Spalding	Sec. 20, Lu Verne	10	Good water in gravel.
C. R. Henton	Sec. 22, Beaver Creek	48	Loam; blue clay; good water from sand layer in the blue clay; stone curbing.
W. T. Henton	Sec. 30, Beaver Creek	68	Loam; blue clay; stopped in blue clay; water foul from the wood curbing.
C. Williams	Sec. 28, Beaver Creek	36	Loam; blue clay; water seeps.
Wm. Grout	Sec. 24, Beaver Creek	24	Loam and clay; good water; the clay was all gravelly, except the very surface soil, with little bunches of sand; water seeps.
Lu Verne House	Lu Verne	16	Good water in gravel.

Material Resources.

These counties contain some of the best farming lands in the state. They are not broken by rock exposure (except through the central part of Rock county), so that nearly all their area is tillable. The rocks that underlie them are not known to hold anything of great economical value. They will serve as a building material, but are rather hard even for that, and it may be found more economical to bring in by railroad the building stones of the eastern counties. The main material product of these counties is now, and will always remain, *wheat*, of which they will produce as much to the acre as any county in the State.

VII.

PALÆONTOLOGY.

Notes on the Fossils of the Trenton in Minnesota.

During the month of July, 1877, some time was given to the examination and arrangement of some of the fossils of the Trenton in the collections of the survey, continuing thus the work begun the season before. As but little time could be had for this part of the work of the survey, the results are meager. The fossils represented by the following list are additions to those named in the report of last year. It was found that a greater range of authorities for reference was necessary for the reliable identification of our specimens, and measures have been taken for procuring many foreign and American works, containing descriptions of the fossils of this horizon.

By reference to the Museum Report accompanying this, the corresponding numbers of the Register will be seen, and other particulars of each species ascertained.

No. 90. *Asaphus extans, H.?* (Compare No. 399). This specimen has been in the museum a number of years, and its origin is unknown; but its similarity to specimens obtained of Mr. W. D. Hurlbut, from Trenton Falls, N. Y., renders its source less doubtful. It is probably from the Trenton formation in Minnesota. It has a tuberculated surface instead of a lamellose one, as *A. extans* is described by Hall.

No. 172. This block contains fragments of the crinoid of Hall, *Schizocrinus nodosus*, with an unidentifiable species of *Murchisonia*, and fragments of a trilobite. *Locality*, Pleasant Grove, Olmsted county.

No. 185. Slabs containing *Strophomena, Orthis, Chætetes, et al.* Fillmore county.

No. 186. *Orthis perveta Con.* These are considerably larger than the type specimens. They are from Taylor's quarry near Fountain, Fillmore county.

No. 189. Fragments of *Asaphus gigas, H.* From Fillmore county.

No. 191. Slab with *Leptæna sericea, Sow. Orthis emacerata, H. Strophomena filitexta, H. and Strophomena, nitens, Bill.;* from Fillmore county.

No. 192. *Poteriocrinites caduceus, H. Orthis testudinaria, Dal. Rhynchonella capax, Con.* are also from Fillmore county.

No. 197. This is provisionally named *Othoceras laqueatum, H.* but the agreement is not satisfactory. *Locality*, Spring Valley, Fillmore county. (Compare No. 214.)

No. 208. *Strophomena tenuistriata.(?)* Compare Nos. 204 and 371. *Locality*, Sec. 17, Rochester, Olmsted county.

No. 214. This slab shows *Leptæna sericea, Sow. Murchisonia bicincta, H. Orthoceras laqueatum, H. Bellerophon bilobatus, Sow. Strophomena, nitens, Bill. and Rhynchonella capax, Con. Locality*, Spring Valley, Fillmore county.

No. 242. *Cyrtoceras arcuatum, H.* has been obtained from Holden, Goodhue county.

No. 243. *Oncoceras constrictum, H.* is from the same locality.

No. 252. *Orthoceras vertebrale, H.* is from the same locality.

No. 269. *Orthis subquadrata, H.* has been identified from Sec. 30, Forestville, Fillmore county.

No. 293. *Strophomena fluctuosa, Bill.* is found in the upper layers of Willson's quarry at Mantorville, Dodge county, which is in the Galena.

No. 294. *Graptolithus scalaris, Linne* is found in the same layers.

No. 297. *Discina Pelopea, Bill.* is found in the same layers. Compare No. 263.

No. 307. *Chætetes petropolitanus, Pan. ?* is found on Sec. 21, Forestville.

At Minneapolis have been identified different forms of *Rhynchonella capax, Con.* and of *Orthis perveta, Con.* The following have also been found at Minneapolis: *Orthis emacerata, H. Var. multisecta, James. Chætetes Lycoperdon, H. Murchisonia bicincta, H. Pleurotomaria subconica, H. Schizocrinus nodosus, H. Cyrtolitès compressus, Con.* and *Bellerophon bilobatus, Sow.*

No. 348. *Cyrtolites compressus, Con.* occurs on Sec. 16, Pleasant Grove, also *Orthoceras strigatum, H.* (Nos. 350 and 381.)

From Pleasant Grove, Olmsted county, also comes *Oncoceras constrictum, H.* (No. 352).

No. 376. *Asaphus gigas, H.*—from St. Charles, Winona county.

No. 397. *Orthoceras vertebrale. H.*—from St. Charles, Winona county.

No. 392. *Orthis bella-rugosa, Con.*—from St. Charles, Winona county.

No. 399. *Asaphus extans, H. (?)* (Compare No. 90). This specimen was obtained of W. D. Hurlbut, and is from Trenton Falls, N. Y. It differs from Prof. Hall's description of *A. extans* in having a surface rather pustulated than lamellose.

No. 410. *Asaphus gigas, H.* and *Strophomena filitexta, H.*—from St. Charles, Winona county.

VIII.

REPORT ON THE GEOLOGY OF RICE COUNTY.

BY L. B. SPERRY.

Situation and Area.

The northern border of Rice county is about 35 miles south of St. Paul, and its eastern border is about the same distance west of Lake Pepin. It is bounded on the north by portions of Dakota and Scott counties; on the east by Goodhue county; on the south by portions of Steele and Waseca counties, and on the west by Le Sueur county. It is four Government townships, or 24 miles, in width east and west. The western portion of the county is of the same length—24 miles north and south—but the eastern two tiers of townships are shorter by 5 miles.

The county contains 14 townships, each of them, except two, containing 36 square miles. Of these two exceptions, one, Bridgewater, contains 40 square miles, and the other, Northfield, 44 square miles.

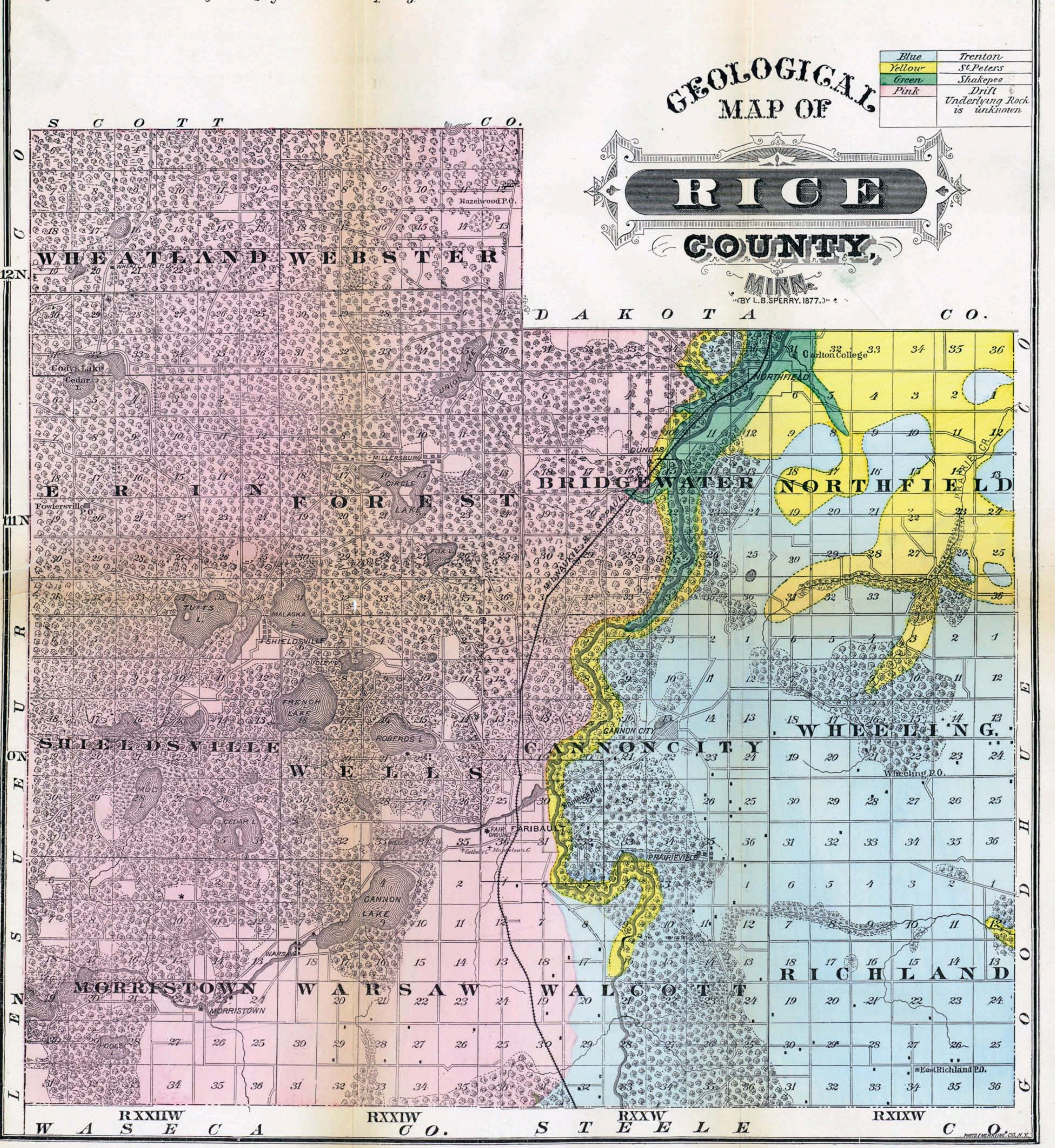
Its area then is 330,240 acres, of which nearly one-half is timber land interspersed with many lakes.

There is but very little land in the county unfit for tillage.

That portion east of the Straight and Cannon rivers is the finest of prairie land, while most of that west of these rivers is, or was originally, covered with valuable timber, which, on being removed, leaves a strong and fertile soil.

Fairbault is the county seat. Northfield, Morristown, Dundas and Shieldsville are the principal towns.

Geological and Natural History Survey of Minnesota. Report of 1877.



Natural Drainage.

The drainage of the county is to the north and east. Straight river enters the county 2½ miles east of the middle of the southern border, and, flowing northward about 8 miles, forms a junction, (where the city of Fairbault now stands) with the Cannon river, which enters the county about 2 miles north of its southeast corner. From the junction of the Straight and Cannon rivers—taking the latter name—the waters flow northward and leave the county 4 miles east of the meridian line upon which the Straight river enters its borders. The western half of the county contains about a score of shallow but pretty lakes, which receive the surface waters of their localities, and empty for the most part by very circuitous routes into the Cannon. The Straight and Cannon also receive the drainage from the eastern portions of the townships through which they flow; while the eastern tier of townships, for the most part, shed their waters through small streams into the Little Cannon and Zumbro rivers in Goodhue county. The Straight river enters the county in the Lower Trenton formation, and cuts through into the St. Peter sandstone 3 miles north of the county line, near Walcott's mill.

A short distance from Walcott's the river makes an extensive bend toward the south, and on reaching Faribault has cut 80 feet into the sandstone.

At a point near the line separating Bridgewater and Cannon City townships the river has cut through the St. Peter sandstone and begins its flow over the Shakopee limestone, into which it has cut about 30 feet when it leaves the northern boundary of the county.

This descent of about 150 feet in crossing the county furnishes at least eleven available mill privileges which have been improved and are in operation.

The following tabular exhibit shows the most important and interesting facts relative to these:

Water Power Mills in Rice County.

Name of Mill.	Owner.	Location.	Stream.	No. of feet fall.	Run of Stone.	Barrels daily.
Walcott	Chaffee & Sheffield	5 miles South of Faribault	Straight R.	....	4	100
Straight River Mills	J. D. Greene & Co.	Faribault	Straight	13	3	60
Kendall	Greene & Gold	Faribault	Straight	7½	4	80
Matteson's	H. M. Matteson	Faribault	Cannon	6	4	80
Polar Star	Stock Co	Faribault	Cannon	8	7	150
Warsaw		Warsaw	Cannon	5	3	50
Hershey's	C. Hershey	Morristown	Cannon	7	2	Custom.
Roberds Lake	J. G. Scott	Outlet Roberds Lake		15	2	50
Cannon City	R. H. Scott	Ne'r Cannon City	Cannon	7	4	100
Dundas Mills	E. T. Archibald & Co.	Dundas	Cannon	9	8	200
Northfield Mills	Jesse Ames & Son	Northfield	Cannon	10	10	300

Surface Features and Soil.

The eastern portion of the county is, for the most part, a high and gently rolling prairie of great beauty and fertility.

Skirting the small streams there is a little timber, and along the east bank of the Straight river—and also of the Cannon, from its junction with the Straight northerly to Dundas—there is a belt of timber averaging about 3 miles wide. The soil bearing this belt of timber is sandy with gravel subsoil, and is of comparatively little value for agricultural purposes.

The surface of the southwest part of the county lies above the Trenton formation and is gently undulating.

The surface of the northeast part is more broken because the Trenton is largely carried away and the St. Peter sandstone is eroded to quite variable depths.

The western portion of the county also is quite undulating—sometimes rough and hilly—and over the greater part is covered with heavy timber, interspersed with many beautiful but shallow lakes.

The surface soil is usually a dark loam, but is generally very thin. A strong and productive yellow clay overlying thick deposits of blue clay—which is frequently exposed—characterize the soil of this region. Maple, Elm and Basswood characterize the timber.

There are about twenty beautiful lakes in the western half of the county, ranging from one to ten square miles in area, and varying from ten to fifty feet in depth. These lakes abound in fish and are much frequented by sportsmen.

The southwestern part of the county, being lower and more sandy, furnishes better beaches for its lakes than are found further north where clay deposits overlie and conceal the sand.

I am under obligation to Surveyor Jewett, of Fairbault, through whose kindness I secured the following:

SURVEYOR'S NOTES OF RICE COUNTY.

Township 109, Range 19.—RICHLAND.

Rolling prairie. Soil a black loam with clay subsoil. The north branch of the Zumbro river flows easterly through the northern part, taking the surface water of nearly the whole town.

Township 110, Range 19.—WHEELING.

Surface rolling, becoming bluffy along the creek. The east branch of Prairie creek heads near the center of the town, where there is a body of about one section of timber. This creek flows northeasterly, and forms a valley from one-eighth to one-fourth of a mile wide, about fifty feet below the general level of the prairie. From the bluffs along this valley in the north part of the town limestone crops out with sandstone below.

Town 111, Range 19.—NORTHFIELD.

Surface mostly a high rolling prairie sloping toward Prairie creek, which runs northeasterly through the township; a part of the town is drained northwesterly toward Cannon river. Soil a rich black loam; clay subsoil; limestone in bluffs along the creek; sandstone below.

Town 109, Range 20.—WALCOTT.

Surface rolling to hilly; slopes toward Straight river, which runs northerly through nearly the center of the town; a body of timber three to four miles wide lies on the east side of the river. Limestone appears in the bed of the river as far north as Sec. 4. North of this point it appears in the bluffs from 20 to 50 feet above the river. Soil in the river valley light and sandy with gravel subsoil; rest of town black loam over clay.

Town 110, Range 20.—CANNON CITY AND FARIBAULT.

Surface quite rolling; bluffy along the east side of river. The Straight river forms junction with the Cannon river in Section 30, from which point the Cannon river runs northeasterly to the centre of the north boundary. The two eastern sections are prairie; the remainder of the town is timber land: soil a rich loam with clay subsoil. Limestone crops out of river bluffs with sandstone below; a small lake in Sec. 15, containing 45 acres.

Town 111, Range 20.—BRIDGEWATER.

Land rolling; becomes bluffy along the river as far north as Section 10. Cannon river flows northeasterly through the eastern part of the town. About six sections on east side of town are prairie; rest of town timber land; soil black loam with clay subsoil, excepting on river bottoms, where the soil is light and sandy over a gravelly subsoil; limestone in the bluffs along the river south of Section 10. In Section 1 it appears in the bed of river.

Town 109, Range 21.—WARSAW.

Surface rolling; drains toward the north; Cannon lake, with an area of 1475.28 acres, lies in the northwestern part of the township; four sections of land northwest of lake are timber land; rest of town is prairie and brush land; soil black loam over clay subsoil.

Town 110, Range 21.—WELLS.

All timber land excepting Sections 35 and 36; surface rolling; soil black loam with clay below; area of meandered lakes 2114.44 acres; drains toward the south.

Rown 111, Range 21.—FOREST.

All timber land; surface rolling; draining eastward; soil black loam, clay subsoil; area of lakes, 1694.41 acres.

Town 112, Range 21.—WEBSTER.

Timber and brush land; surface rolling: drains to the south and east; soil light-colored loam over clay. Area of meandered lakes, 208.81 acres.

Town 109, Range 22.—MORRISTOWN.

Nine sections in southeast part prairie land; remainder of town timber. Cannon river flows easterly through the center of township; surface rolling, slopes towards the river; soil a rich black loam with clay subsoil. Area of meandered waters, 935.70 acres.

Town 110, Range 22.—SHIELDSVILLE.

Surface rolling, becoming hilly in some parts of the town; soil black loam over clay. Area of lakes, 2574.23 acres. The Cannon river heads in Tuft's lake, in Section 3.

Town 111, Range 22.—ERIN.

Surface rolling to hilly, timber and brush lands; soil rich loam over clay. Area of lakes, 856.32 acres.

Town 112, Range 22.—WHEATLAND.

Surface rolling and hilly; soil black loam on clay subsoil; timber and brush land. Area of lakes, 307.27 acres.

Timber.

As before stated the eastern portion of the county originally produced timber only along the streams. Through cultivation for shade, hedges, protection from winds, &c., timber is increasing over this area.

The western half of the county was originally covered with heavy timber—excepting a few limited, enclosed spaces, which were open prairie, or sparsely covered with oak and under-brush—and forms a part of what is denominated the "Big Woods."

This region is being cleared up rapidly and there are now many fine farms in every township of the timber regions of this county.

The following list embraces all the native trees and shrubs that were noticed during the survey. It is not believed, however, that it includes all that grow naturally in the limits of the county:

Basswood. Tilia Americana. *L.*
Smooth Sumach. Rhus glabra. *L.*
Jersey Tea. Ceanothus Americanus. *L.*
Sugar Maple. Acer saccharinum. *Wang.*
Silvery Maple. A. dasycarpum. *Ehr.*
Red or Swamp Maple. Acer rubrum. *L.*
Box-Elder. Negundo aceroides. *Mœnch.*
False Indigo. Amorpha fruticosa. *L.*
Locust. Robinia Pseudacacia. *L.* Cultivated.
Cherry. Prunus.
Red Raspberry. Rubus strigosus. *Michx.*
Blackberry. R. villosus. *Ait.*
Crab. Pyrus arbutifolia. *L.*
Dogwood. Cornus paniculata. *L'Her.*
Wolfberry. Symphoricarpus occidentalis. *R. Br.*
Ash. Fraxinus.
Slippery Elm. Ulmus fulva. *Michx.*
Butternut. Juglans cinerea. *L.*
Walnut. Juglans nigra. *L.*
Hickory. Carya.
Burr Oak. Quercus macrocarpa. *Michx.*
Black Oak. Quercus coccinea. *Wang.* Var tinctoria. *Bartram.*
Wild Hazle-nut. Corylus Americana. *Walt.*
Iron-wood. Ostrya Virginica. *Willd.*
American Aspen. Populus tremuloides. *Michx.*
Cottonwood. P. monilifera. *Ait.*
Large-toothed Aspen. P. grandidentata. *Michx.*
Balm of Gilead. P. balsamifera. *L.* Var. candicaus. *Ait.*
Red Oak. Quercus rubra. *L.*
White Oak. Quercus alba. *L.*
Wild Plum. Prunus Americana.
American Elm. Ulmus Americana. (*Pl Clayt.*) *Willd.*

American Crab. Pyrus Coronaria. *L.*
Black Cherry. Prunus serotina. *Ehr.*
Bitternut. Carya amara. *Nutt.*
Wild Red Cherry. Prunus Pennsylvanica. *L.*
Thorn Apple. Cratægus Crus-galli. *L.*
White Birch. Betula alba. *Var.* populifolia. *Spach.*
Small Cedar. Juniperus Sabina. *L.* *Var.* procumbens.
White Pine. Pinus Strobus. *L.*
Water Beech. Carpinus Americana. *Michx.*
Cornel. Cornus paniculata. *L'Her.*
Cornel. Cornus circinata. *L'Her.*
American Woodbine. Lonicera grata. *Ait.*
Juneberry. Amelanchier Canadensis. *Torr & Gray.*
Dwarf Wild Rose. Rosa lucida.
Pipe Vine. Aristolochia Sipho.
Grape. Vitis cordifolia. *Michx.*
Virginia Creeper. Ampelopsis quinquefolia. *Michx.*
Nine Bark. Spiræa opulifolia. *L.*
Bittersweet. Celastrus scandens. *L.*
Rose. Rosa blanda. *Ait.*
Lombardy Poplar. P. dilitata. *Ait.*
Speckled Alder. Almus incana. *Willd.*

GEOLOGICAL STRUCTURE.

In general the drainage of Rice county is toward the north and east, which fact indicates the relative elevations.

The Chicago and Milwaukee R. R. survey (Minnesota Div.) found the elevations of the natural surface, where the railroad crosses the northern line of the county, to be over 1050 feet above the sea level. At Faribault depot it is 993 feet; at Dundas depot, 945 feet; at Northfield depot, 905 feet. The entire western half, and the southeastern portions of the county have a higher elevation. I have no means of knowing positively the relative elevations or the highest point in the county; but judging from appearances I conclude that the rolling prairie, on which Cannon City is located, is the highest by least 100 feet.

The only geological formations that appear in this county are the

Loam,
Drift,
Trenton Limestone,
St. Peter's Sandstone,
Shakopee Limestone.

In *general appearance* these formations are not unlike the same formations as they are seen in other portions of the State, and carefully described by Professor Winchell in his reports made during the past few years. Nor did I find in the county any remarkable *special peculiarities* in any of the formations.

The *Loam* is deep, dark-colored and fertile, over nearly all the eastern portion of the county ; but over the western portion as a rule it is thin.

Drift, consisting largely of blue clay over-lain by a grayish yellow clay, characterizes the soil of the western half of the county. Boulders of granite, gneiss, trap and porplyry are quite abundant in some places ; but fine clay, with small quantities of gravel, are the rule throughout this region. No well yet dug in the western part of the county has passed through the blue clay—though some of the wells are over 100 feet deep. A hint as to the depth of the clay is found in the fact that a well dug last season south of Rice county, about 30 miles west of Owatonna—near Janesville—after passing through 200 feet of blue clay reached a sandstone said to be identical with the St. Peter's in appearance. An abundance of good water, which rose to within 30 feet of the surface, was found between the clay and the sandstone. This fact should be considered by the residents of this drift and timber region, as many of them have failed to secure good and abundant water in the clay. Indeed there is much uncertainty about getting *good* well water in this region. Some holes at 100 feet or over fail to bring enough water for drinking and cooking purposes. Some wells that furnish an abundance of water are so strongly impregnated with mineral impurities as to be nearly useless, while others are quite pure. It is possible that good water which would rise nearly to the surface might invariably be procured by boring through the clay to the under-lying rock.

Illustrations of the peculiarities of the deposits in this region are seen in the following facts : On the S. E. side of Union Lake (7 miles west of Northfield) Mr. B. Benton dug 40 feet and secured an abundance of water, but is strongly impregnated with some mineral impurities. About 40 rods from there Mr. M. J. Punk secured better water at 16 feet ; and about 40 rods further Mr. S. A. Amsden secured nearly pure water at a depth of 36 feet.

It has been supposed by some that the formation underlying the drift throughout the timber region is the Cretaceous, and I see that Prof. Harrington in his report on Steele county expresses his belief in the existence of the Cretaceous along that belt. I am not satisfied that such is the fact. To my mind there is but very little evidence of it; but I do not desire to discuss ths matter till I have procured more light on the subject. At present my belief is that the drift rests immediately upon a thin remnant of the St. Peter sandstone. Perhaps in some places the St. Peter is all eroded so that the drift rests immediately upon the Shakopee.

Reference to the accompanying colored map of the county will show the areas of the different formations as they give evidence, by exposure and by topography, of underlying the deposits of drift and loam.

It will be seen that the Trenton limestone is nearly removed from the western part of the county, the bluffs along the Straight river to a point a little south of Faribault, and a hill near Northfield, being the only places where it occurs. East of the river, however, it is extensive, and furnishes abundance of material for building purposes of which mention will be made under the head "Material Resources."

In general character the Trenton resembles so closely that found in other parts of the State, and so carefully described in previous reports on the survey of the State, that little need be said here.

For building purposes the most of that found in this county is superior to that quarried near St. Paul, in that it contains less clay and does not weather so easily. On the other hand the Rice county limestone contains more concretionary iron pyrites, and, hence, necessitates more care in its selection for architectural purposes.

The Straight river cuts through the Trenton and enters upon the St. Peter at Walcott's mill, 3 miles south of Faribault. At a point eight miles further north the river (having now become the Cannon) has worked its way through the St. Peter and enters upon the Shakopee. The thickness of the St. Peter, in Rice county, is from 100 to 125 feet. It appears in the form of cliffs at frequent points along both sides of the river from the place where it is first reached by the Straight to the northern limits of the county, and in the northeastern part of the county it frequently appears in the hills—indeed it largely gives character to the topography of this section.

Judging from the topography also I am satisfied that many of the hills in the northwestern part of the county—in Wheatland and Webster townships—consist largely of the St. Peter; but they are so heavily covered by drift and timber that I could neither find nor learn of any exposures. In Cedar Lake there is an island the topography and flora of which indicate the St. Peter, capped with Trenton. I was unable to verify this by excavations.

There is no place in the county where the St. Peter sandstone is sufficiently compact and firm for building stone. As along the

Mississippi, it may be removed by pick and shovel. In color it is—as along the Miss. river—white to red, according to the percentage of iron, and its oxidation resulting from exposuse. No fossils are found in it here.

The Shakopee limestone is reached by the Cannon river at a point about 4 miles south of Dundas—6 milns south of Northfield.

On leaving the county one-half mile north of Northfield, the river has cut into the Shakopee about thirty feet. The map shows approximately the extent of this formation as exposed. The descriptions of it in preceding reports will apply to the formation as seen here.

Material Resources.

Limestone—both for building-stone and for quick-lime—and sand for mortar, are abundant along the valleys of the Cannon and Straight rivers, and throughout the western half of the county; while in the western portion no limestone is found.

Good clay for the manufacture of brick is sufficiently abundant all over the county.

Stone Quarries

are abundant throughout the eastern half of the county. The bluffs throughout this region are capped by a layer of the Trenton varying from a few inches to several feet in thickness.

The various neighborhoods of this section have their quarry, or quarries, from which all the building stone for general purposes is easily obtained.

Prairie Creek Valley has scores of quarries opened along its bluffs; and the valley of the Cannon looks up to as many more. Good coursing-stone is furnished at Northfield for about $6 00 per cord.

At "Fall Creek," 3 miles east of Faribault, there is a fine deposit which is being extensively quarried by its owner, Mr. Phillip Cromer. The deposit of limestone here is about 12 feet thick and is covered by about 4 feet of drift and loam. The strata in this quarry range from 3 to 12 inches in thickness and are easily quarried. The upper stratum, 8 inches in thickness, is quite light-colored and filled with fossils which are so thoroughly cemented and transformed as to render the stone compact, while its fossiliferous nature is still clearly apparent. But few specimens of fossils can be enucleated. The rock is infiltrated by gypsum and Iron Pyrites which often cement its seams quite firmly.

Mr. Cromer sells undressed stone for prices ranging from $5.00 to $15.00 per cord. The greater part of his business however is in the best varieties, which he sells by the cubic foot, at prices ranging from 25 cents to 75 cents.

Mr. N. Lord, 2 miles south of Faribault on the west side of the river, has two quarries opened, from which he has sold as high as 300 cords in one year.

In Richland township, bordering on Goodhue county, Messrs. Halver Johnson and Peter Halverson have each a fine quarry at which I saw about 100 cords ready for market.

Messrs. I. Lenhart, A. Revere, C. Stetson, D. Furguson and P. Oleson are the principal quarrymen in the vicinity of Northfield; and on Prairie Creek, in Wheeling township, Messrs. J. Thompson, A. Knapf and S. Aslagson do quite an extensive business in quarrying for their neighbors.

Lime Kilns.

The upper four strata of the Lower Trenton formation as exposed in this county furnish tolerably good material for quick-lime, though in some places the deposit is too silicious, and in no place is the lime obtained sufficiently white for fine work. When first burned the lime is yellowish in color, but when slacked is nearly white. It is excellent lime for stone work.

Though lime has been burned in every township of the county east of the Cannon river, it is not now made a regular and paying business except at Phillip Cromer's kiln, on Fall Creek, near Faribault. Mr. Cromer uses a patent kiln and burns from 3,000 to 3,500 barrels a year, which he sells at 65 cents per barrel. Three other kilns near Fairbault, owned respectively by Messrs. Pond, Lee and Lord, burn in the aggregate about 1,000 barrels per year. There is a kiln one mile from Northfield, in Dakota county, which supplies Northfield and vicinity. This kiln burns its lime from the best strata of the Shakopee formation. In general character the lime is like that of the Trenton.

Brick.

Rice county contains an abundance of clay for the manufacture of brick but none has been found sufficiently free from iron to make the white or cream-colored brick. At Faribault Mr. J. G. McCarthy makes about 700,000 per year, which he sells at $6.00 per thousand. One season he made one million. All the clay of this section is so clear that to make good brick it is necessary to add sand.

Henry Durham, of Faribault, burns about 300,000 per year and finds lying immediately under the clay a stratum of sand for mixture with it.

Another brickyard has been started at Faribault this season. Its character and success are not determined. At Prairieville, Messrs. Meisner and Leonard are making about 300,000 per year. Their brick are said to contain considerable lime and to be very good. At Morristown, Mr. Pettiel makes abont 50,000 per year. Three miles northeast ot Faribault, Mr. Dungay is making the best brick yet produced in the county. His product so far has been but about 100,000 per year, but these have been sold at from $7.50 to $8.00 per thousand. At Shieldsville one kiln is burned each year for home supply, and at Northfield one or two small kilns are burned every season.

During the past season a bank of clay has been opened about three miles from Northfield and brick for the new college building (St. Olaf's) have been burned. They are pronounced of fine quality.

In making the survey of this county I am especially indebted to Surveyor Jewett, of Faribault, for surveyor's notes of the county, to Professor J. J. Dow of the State Blind Asylum, at Faribault, for his valuable company and assistance during several of the days occupied in field work, and to Professor B. F. Thomas of Carleton College, who also rendered valuable assistance.

At some convenient time in the future I shall hope to make a *supplementary report* concerning some further facts and features pertaining to the Geology of this county.

IX.

CHEMISTRY.

REPORT OF PROF. PECKHAM.

Prof. N. H. Winchell,

My Dear Sir:—The chemical work for the Geological Survey during the last year has been as follows:

The analysis of the ashes of 17 specimens of peat.
The analysis of four specimens of peat as fuel.
The analysis of the water of the Belle Plaine salt spring, so-called.
The examination of 13 specimens of water from the Red River Valley.
The examination of 3 specimens of water from Brainerd.
The examination of three specimens of limestone, and of concretions from the brick clay at Minneapolis.

The results of the examination of the peat and peat ashes are herewith submitted. The water from Belle Plain was procured by myself about the first of last May. On reaching Belle Plaine I enquired for the spring from which the salt water had formerly been obtained and was informed that the bank had caved in upon it and it was filled up with earth. I was further informed that the water oozing from the base of the bluff was as salt as any water about there. I then enquired about the well and the possibility of getting some water from the boring. I was informed that no water could be procured from that source as the pump had been taken out and the level of the water was many feet from the surface. The station agent confirmed this information and I saw no other resource but to collect such water as I could from that flowing from the bluff. I brought this to the Labratory and soon found that this specimen was nothing more than hard well water, confirming the results of the examination that I made in 1873-4. I afterwards met a gentleman who resided in Belle Plaine, who confirmed the statement previously made to me that I had probably got a specimen of as salt water as any that was to be had there now.

Having ascertained that there was a comparatively small amount of solid matter in the water, of which only a very small proportion was chlorides of any kind, that the water contained principally bicarbonates of lime and magnesia with some sulphates and chlorides; in fact, as stated above, that the water was nothing but a hard well or spring water, I concluded that it would be useless to make an estimate of the gasses dissolved in the water, or of the substances contained in small quantity, and therefore after completing the estimates then begun I did not continue the examination further.

But one of two conclusions can be entertained in reference to these results; either the wrong water has been examined or the Belle Plaine salt springs do not yield salt water. I purposely avoided seeking any parties at Belle Plaine who had been hitherto interested in the salt operations there, as I did not wish to prejudice my results for or against any persons or interests.

The examination of the specimens of Red River water made during the summer vacation have been previously reported upon.

The examination of the water from Brainerd has been already reported upon.

The Belle Plaine Water.

Mineral matter in solution		25.10	grains	to gall.
Organic and volatile matter in sulution		5.37	"	"
Total solid matter in solution		30.47	"	"
Chlorine, Cl		3.152	"	"
Silica, SiO_2		1.465	"	"
Ferric, aluminic and phosphoric oxide	Fe_2O_3, Al_2O_3, P_2O_5	.068	"	"
Barium sulphate	$Ba\ SO_4$	A trace	"	"
Sulphuric oxide	SO_3	1.033	"	"
Lime	CaO	5.896	"	"
Magnesia	MgO	.544	"	"

Alkalies and carbonic oxide (CO_2) were not determined.

Peat Ashes.

Number.	Silica, SiO_2.	Carbon.	Iron and Iron Phosphate. Fe_2O_3 and $Fe_2P_2O_8$.	Lime, CaO.	Magnesia, MgO.	Sulphuric Acid, SO_3.	Undetermined.	Remarks.
16	51.30	1.81	9.30	10.89	6.12	5.19	15.39	CO_2 and H_2S in large amount.
17	83.13	.86	7.99	5.44	1.75	.78	.05	Alkalies a trace.
18	83.35	.03	5.29	7.39	.97	2.57	.40	Alkalies a trace.
19	72.79	.95	9.46	5.92	6.13	trace	6.25	CO_2, small ; $Fe_2P_2O_8$ 5.92.
20	80.55	.75	10.23	5.61	.76	1.34	......	CO_2, trace P_2O_5 trace.
21	82.71	1.19	7.41	3.18	trace	3.70	1.81	CO_2, a trace.
22	64.37	.16	21.41	6.26	1.54	7.58	......	P_2O_5 a trace.
23	72.64	.75	15.46	5.87	trace	5.73	......	P_2O_5 a trace.
24	68.06	1.34	8.82	5.03	4.81	6.53	......	CO_2 strong ; P_2O_5 trace.
25	88.28	1.32	6.34	.84	.51	trace	2.71	CO_2 very small ; P_2O_5 & Alkalies a trace.
26	64.27	2.80	9.75	15.75	1.77	3.69	2.57	CO_2 very strong, P_2O_5.
27	81.99	1.14	9.39	4.84	.60	1.12	......	P_2O_5, Alkalies a trace.
28	79.24	.15	5.65	7.60	.98	2.76	3.62	CO_2 strong, Alkalies a trace.
33	57.23	1.45	16.50	11.47	2.09	8.71	2.55	CO_2 strong.
34	57.35	1.48	17.09	17.84	trace	4.79	1.45	CO_2 strong.
35	55.30	5.57	11.26	19.04	trace	3.26	5.57	CO_2 strong
36	63.71	1.60	10.50	11.83	3.98	2.70	5.60	CO_2 strong.

No.	Total Volatile.	Total Combust.	Ash.	Remarks.
33	7.97	43.34	48.69	Had been dried about three years.
34	8.03	45.32	46.65	Had been dried about three years.
35	13.43	70.96	15.61	Had been dried about three years.
39	12.37	67.14	20.49	Had been dried about three years.

Nos. 46, 47 and 48 are limestones.* They were examined for the total amount of matter insoluble in hydrochloric acid, water, iron, alumina, phosphate of iron, lime and magnesia in the soluble portion. As there was only a trace of soluble silicate and phosphates the lime and magnesia were calculated as carbonates. No. 47 gave a small per cent of alkalies, not an unusual ingredient of lime stones. Nos. 46 and 48 gave only a trace of alkalies.

*No. 46 was a sample of the common building-stone from Minneapolis—" No. 5 " of the section below the University, Report for 1876. p. 149.

No. 47 was a sample of the building-stone from Taylor's quarry. near Fountain, Fillmore county, and was compact and non-argillaceous.

No. 48 was a sample of the impure limestone from Minneapolis, from "No. 1 " of the section below the University. Report for 1876, p. 148.—N. H. W.

Analysis gave the following results:

No. 46.

Portion insoluble in hydrochloric acid	14.45	per cent.
Water (H_2O)	1.60	"
Ferric oxide (Fe_2O_3), Alumina (Al_2O_3) / Ferric phosphate ($Fe_2P_2O_8$)	1.70	"
Carbonate of Lime ($CaCO_3$)	75.482	"
Carbonate of Magnesia ($MgCO_3$)	6.810	"
	100.043	"

Alkalies, sulphuric acid and solouble silica, of each a trace.

No. 47.

Portion insoluble in hydrocloric acid	9.890	per cent.
Water (H_2O)	0.240	"
Ferric oxide (Fe_2O_3), alumina (Al_2O_3) / Ferric phosphate ($F_2P_2O_8$)	1.300	"
Carbonate of Lime ($CaCO_3$)	86.107	"
Carbonate of Magnesia ($MgCO_3$)	00.470	"
Alkalies	.440	"
	99.447	"

Sulphuric acid and soluble silica, of each a trace.

No. 48.

Portion insoluble in hydrochloric acid	16.220	per cent.
Water (H_2O)	0.375	"
Ferric oxide (H_2O), Alumina)Al_2O_3) / Ferric phosphate ($Fe_2P_2O_8$)	3.075	"
Carbonate of Lime	54.533	"
Carbonate of Magnesia	36.002	"
	100.205	"

The magnesia is a fraction of one per cent too high. Alkalies, sulphuric acid and soluble silica, of each a trace.

These results would give these limestones the following values for burning into lime. If completely burned,

100 pounds of No. 46 would give 61 pounds of lime.
" " " " 47 " " 60 " " "
" " " " 48 " " 62 " " "

Of the 61 pounds of No. 46, 45.5 pounds are available for mortar.
" " 60 " " " 47, 49 " " " " "
" " 52 " " " 48, 42.5 " " " " "

The mortar from Nos. 46 and 47 would be nearly a pure lime mortar, that from No. 48 would be one-third a magnesian mortar.

One houndred pounds of pure carbonate of lime will yield fifty-six pounds of lime, after burning, all of which would be available for mortar.

Practical results would vary somewhat from the above as more or less skill was exercised in burning the limestone.

No. 54. Lime Concretions found in the Brick Clay at Minneapolis.

Matter insoluble in hydrochloric acid, chiefly Fe_2O_3	4.62	per cent.
Calcium Carbonate	94.83	"
	99.45	"

There was also a trace of magnesium carbonate and organic matter.

Feb. 25, 1878.

Report on Serial Nos. 49, 50 and 51, Well Waters from Brainerd.

Owner's Name.	Serial Number.	Total Solid Residue.	Mineral Residue.	Organic and Volatile Residue.	Permanent Hardness.	Removable Hardness.	Total Hardness.	Chlorine.	Free Ammonia—Pts in 100,000,000.	Albuminoid Ammonia—Pts in 100,000,000.	REMARKS.
C. H. Alsop...	49	31.287	24.283	7.004	8.172	6.421	14.593	42.728	132.	49.	Sulphuric and Carbonic acids, a trace.
Al. White.....	50	16.519	13.250	3.269	6.129	3.210	9.339	4.027	0.	9.	" "
Leland House.	51	37.241	30.937	6.304	9.923	4.378	14.301	50.900	26.	13.	" "

These waters are very unlike. No. 49 is a hard well water, very bad indeed from free and albuminoid ammonia. The latter might be derived from decomposing vegetation, but the free ammonia in such large quantities gives unmistakable proof, in the absence of other causes for its presence, of sewage contamination. No. 49 also contains a very large proportion of chlorine which is also proof of contamination. No. 50 is a pure well water, somewhat hard, but very free from ammonia in any form. The amount of chlorine is also small. No. 51 is harder than No. 49. It contains less ammonia than 49 but still sufficient to indicate contamination, especially when considered with the large amount of chlorine that it contains. All three of these waters contain only a trace of sulphuric acid SO_3 and a very little carbonic acid (CO_2). In waters containing so much chlorine it is useless to attempt to estimate calcium and magnesium with soap; the method of Parke's does not answer, excepting for those waters containing carbonates as I have stated in a former report.

Nothing in the appearance of these specimens would indicate that there was any difference between them or that they were unlike ordinary well or spring water.

Respectfully submitted,
S. F. PECKHAM.

MINNEAPOLIS, MINN., Dec. 11th, 1877.

P. S.—Dec. 29th. In 49 and 51 the chlorine appears greater in amount than the total solid matter. This chlorine is correct and doubtless exists in some volatile form. There was not water enough for me to ascertain to what cause the discrepancy is due, but the reason assigned above is I think adequate.

S. F. P.

X.

ENTOMOLOGY.

REPORT OF ALLEN WHITMAN.

Prof. N. H. Winchell, State Geologist:

SIR :—I have the honor to contribute to The Geological and Natural History Survey of Minnesota the following entomological notes for the year 1877. They refer mostly to the locust, with the disappearance of which we are left once more to contend only with some of the common pests of the garden, and of fruit, shade and forest trees. In this respect we are fortunate that we still lie outside of the range of some of the most pestilential enemies of the grain and corn fields ; and although a persistent cultivation of any growth will probably bring in time all the insect enemies of that growth which are capable of existence and reproduction here, we are subject for the present only to the attacks of enemies not numerous in species nor excessive in number when compared with those of longer cultivated and more thickly settled States. These however are troublesome enough and are attracting more and more the attention of our horticultural and agricultural societies, as they have already attracted that of the few gentlemen in the State who have been able to devote to the study of Entomology a portion of the time largely due to other pursuits.

It is hardly the work of the Geological and Natural History Survey to furnish instruction in elementary or economic entomology. Circumstances have made it seem necessary or desirable to collect all possible information on the subject of the locust, particularly that species which has become so well known in this State of late years, in regard to which much is still to be learned, and which is still a kind of fabulous bugbear to those States which are free from it. For the purpose of completing what has already been written in previous reports, the subject is here continued. But that there are other insects in regard to whose habits, together with the best means of protection from them, our farmers and gardeners could be profitably instructed, is shown by the attention which has been paid to the subject during the past year at the meetings of our horticultural and agricultural societies, and by the (unsuccessful) attempt made in the last legislature to obtain a meagre appropriation for the purpose of issuing a pamphlet to meet the supposed need of it. It is too often the case that the inability to provide against injuries results from a lack of that knowledge of the growth and transformation of insects that ought to be in the possession of even the children in our common schools; while many pests which are practically known to every gardener while in their destructive stage, are wholly unknown to him in those stages when they are preparing to commit future injury. The State Entomologists of Missouri and Illinois (and perhaps other States,) have considered it worth their while to preface their earlier reports with brief manuals of elementary entomology. A small pamphlet of this kind with brief notices of the form, growth and habits of some of our most common species of injurious insects might be issued by the Agricultural Department of the State University (as has been done at the Agricultural College of Michigan,) and would render great service. In addition to this every one who is interested in the matter may contribute by sending to the Museum of Natural History at the State University, specimens of every kind of destructive insect, in all forms or stages of it that are capable of preservation. A collection formed in this way would in time become of great practical value, and at the meetings of the horticultural and agricultural societies at Minneapolis, would become available to a large number of persons.

Not to go outside of our cities, a large percentage of the yearly injury or ruin to our shade trees, is occasioned or increased by insects, while oftentimes the owners entertain no suspicion of the cause of the evil. We set out maples again and again, to be seriously damaged by the havoc of boring-beetles or of the Maple Aegerian, while the box-elders are defoliated and rendered unsightly by the caterpiller of an insignificant yellow moth.

Outside of the cities, in addition to the damage inflicted by the locust, the Colorado Potato Beetle has done perhaps more injury than in any year since 1870, while certain blister-beetles and the potato-stalk weevil have been more noticeable than before. While this is in writing the report of the Hon. T. M. Metcalf, Commissioner of Statistics, for the year 1877, states that the Chinch Bug has committed considerable injury in Houston county during the year. As this is an enemy to a considerable extent unknown to our farmers, I add a few brief notes in regard to it, with the hope that they may be of some value, if the evil makes its appearance again this year.

Another insect which has appeared in far greater numbers than usual during the year is the Tent Caterpillar of the Forest, (Clisiocampa Silvatica. Harris.) [Vid. Harris' Report p. 375 and Riley's Third Annual Report of the State of Missouri.] These were abundant about Brainerd, as is shown by the following :

BRAINERD, MINN., July 6th, 1877.

DEAR SIR :—I send you by express a few specimens of the army worm. East of this place they are very abundant, and the northern limit of this caterpillar is unknown. They have been observed one hundred and fifty miles north of us (by the Mississippi river) on that stream.

They eat the oak and bass wood only. In the vicinity of Island Lake on the line of the N. P. Railway, they have been very plenty, but are decreasing, advancing southward.

Yours most truly,
J. C. ROSSER.

The following extract probably refers to the same insect:

"The caterpillars have again made their appearance in large numbers in the timber in the vicinity of Eagle Lake, and are eating the foliage of the trees, in many instances almost stripping them bare. Last year they occupied the same district, covering a district from four to six miles in extent. This year they are more numerous, and we suppose are gradually extending their operations."—*Mankato Review, June 12th, 1877.*

The works referred to above describe this insect very fully, and give the means of preventing its increase.

THE ROCKY MOUNTAIN LOCUST.

The area of the egg deposits for the year 1876 will be found on the "Map of Locust Areas," in the report of the Geological and Natural History survey of that year. The statements upon which this was based came from over six hundred townships in about forty counties. The reports as to the density of these deposits varied greatly in the different counties. It was generally thought that there were very few or no eggs along the Dakota line, and in most of the territory where the young had hatched in 1876 ; that they were more numerous along the eastern line of the egg-area, where however but comparatively few appeared in the Spring ; and more numerous still in a strip of country reaching southeastward from Otter-Tail to Blue Earth and including those counties, and in fact it was in this strip of territory out of all the locust region from Minnesota to Texas, that the greatest damage of the year 1877 occurred. The eggs were also thickly laid in the southern range of counties from Rock to Freeborn as well as in nearly every county in Iowa lying south of these, but all this portion of the locust region, both in Minnesota and Iowa, escaped with far less damage than had been expected, and in nearly every case with the best crops known for years.

PROGRESS DURING THE SPRING.

The locust events of the spring and summer were a succession of hopes and disappointments, ending finally in a large measure of unexpected success. The warm weather of February, followed by severe cold in March, seemed to exert in most cases no appreciable effect upon the vitality of the eggs. It was forgotten that the weather reports of March and April for the past four years would show that the eggs are almost every year subjected to more or less freezing and thawing. When the hatching time came the young failed, for various causes, to appear in large numbers, in many places where the eggs had been laid at least as thickly as in previous years; but on the other hand they came forth in such overwhelming numbers in other places, that the unequal conditions of the different parts of the locust area, added to all the uncertainties of what the next few weeks would bring, rendered the loosely drawn and self-contradicting bounty law* of 1876 an obvious failure, and no steps were ever taken to carry it into effect. The prospect during the last ten days of May was disheartening. In thirteen counties, in parts of some and in nearly the whole of others, clean sweeping destruction of wheat and serious injury to many other crops were already in progress, while in about twenty other counties the young had appeared in sufficient numbers to cause great apprehension. From the first of June onward there was marked improvement; where the locusts were excessively numerous and where the wheat had been trimmed to the ground at that date, the crops failed to recover; but where the growth still remained or had not been badly eaten, the comparative amount of injury grew less from day to day until the crops for the most part were safe except from migrating swarms. Then followed a series of migrations in July and August, which though they added a little to the territory already injured, were so different from those of other years as to be mainly harmless. The result of all this was far different from anything which could have been expected in May, and the returns of the Commissioner of Statistics for 1878 will probably show that the locusts destroyed more bushels of grain in 1877 than have been

GENERAL LAWS OF MINNESOTA FOR 1877; CHAPTER 86.—The act appropriates $100,000 for the destruction of grasshoppers and their eggs. The bounty is to be paid only to persons living within counties affected by grasshoppers. The sums to be paid are as follows: fifty cents per gallon for eggs; one dollar per bushel for grasshoppers caught previous to the 25th of May; fifty cents per bushel from the 25th of May to the 10th of June; twenty-five cents per bushel from the 10th of June to the 1st of July, and twenty cents per bushel from the 1st of July to the 1st of October. Instead of "caught" it would be better to use the word "delivered," for obvious reasons.

Other sections provide for the delivery of captured grasshoppers to measurers appointed (by the Governor) for each township, and for payment of bounty through certificates issued by county auditors, audited by boards of county commissioners, filed with the State Auditor, and paid with his warrant upon the State Treasurer. Although the provisions of the act extend to October 1st, the money appropriated by the act can be applied only to the payment of certificates filed with the State Auditor on or before July 15th. If the amount of these certificates exceeds $100,000 they are to be paid by the State pro rata to the amount of $100,000, and the balance in full paid by the counties according to the amounts due on certificates issued by each county. Furthermore; "no other or greater amount than $100,000 shall ever be paid under the provisions of this act."

It is entirely an unfair proportion between the price to be paid up to May 25th (one dollar per bushel, which is none too much) and from June 10th to July 1st, (25 cents per bushel,) when the locusts are in the pupa or winged state, and may easily be caught by the barrel, after nightfall. One farmer estimated the amount caught by him at this period at 400 bushels; another at 800 bushels. Besides this, it was obvious before May ended that a few of the worst infested counties would easily exhaust nearly the whole appropriation, perhaps without saving any great amount of crops; while others (which finally escaped almost unharmed without any use of the bounty law,) would have to be responsible for nearly the whole of its bounty certificates.

Other sections provide for one day's labor per week of all males between twenty-one and sixty, in the several townships of the afflicted counties, for five weeks after the grasshoppers become large enough to be caught easily; such labor to be performed under the direction of overseers of highways, who are to give notice of the time and place where it is required.

This is liable to call a man away from the defence of his own field at the very time when he is most needed at home. The same amount of labor, assessed *before the grasshoppers hatch*, in destroying eggs, or in ditching to prevent incursions, would prove far more effective.

destroyed in any other year, and that the amount left to harvest fully equalled any annual crop yet produced.

The causes of this unexpected result are for the most part a series of favorable climatic conditions. As in the year 1876 the returns of locust damage inflicted mostly in July and August, included a considerable diminution of the wheat crop by drouth in June, so, on the other hand, counties harvesting a full average crop in 1877 will probably report no damage, even where the crop was really somewhat reduced by the locusts. For once, the farmer, taking the annual chances of rain, hail, blight, drouth, insects and other destructive agencies to which he is from time to time subjected, has found the influences of climate to be so largely in his favor as to offset what otherwise promised to be an unmitigated evil, and if it is not probable that the state will be often overrun by locusts in any series of years, it is still less likely that in any one "locust-year" the hatching will again be reduced to a nullity through so large a portion of the egg-area. But that events of this kind do actually repeat themselves in the long run, is shown by the fact that the locust events of 1857 (so far as they can be recalled) are almost exactly repeated in 1877, in the thick deposit of eggs, in the character of the spring weather, in the damage which proved less than anyone had expected, and in the final departure of the migrating swarms in July and August to some unknown destination from which they failed to emerge in great numbers for several years. Of course all that is here stated of the successful results of the harvest of 1877 is said with a full knowledge of the sweeping destruction in some of the worst ravaged counties, but also with a consideration of all those counties where the locusts failed to inflict injury, and where it would have surely followed in a spring resembling that of 1876.

Other and less considerable causes tended to reduce the expected percentage of injury. These were, a certain but hardly calculable amount of destruction of the eggs by insect and other enemies, and a partial failure of the eggs to hatch, "from causes unknown;" a comparatively trifling destruction of the young by snow storms at the end of April; and, more efficient wherever applied, the destruction of the eggs by plowing and harrowing the egg-beds during the fall and spring, and the destruction of the young with ditches, tar-pans, nets, and other contrivances. To this must be added that in some cases where the young were fully as numerous as in other years they were far more harmless, and also that eggs deposited in September and October, 1876, were hatched so late that the crops were mostly beyond the reach of the young.

HATCHING.

The cases of reported hatching in February were, so far as ascertained, entirely the appearance of native species. All of those sent me were of a size that generally precluded the possibiltty of their having hatched in February. Three of our common native species were received, of which two became winged in the first week of March, but neither of the same species was observed in the fields until the 25th of May. The young (perhaps of Spretus) were seen in our southern counties by the 10th of April, and by the 20th of the month had appeared in considerable numbers along the river bluffs between St. Peter and New Ulm. Part of these, and perhaps all, were destroyed by a storm which came about a week later, but they were only a trifling portion of all that were to appear. Innumerable newspaper items, letters, and replies to circulars show that it was not until the first ten days of May that the eggs hatched in greatest numbers, with slight difference between the dates of appearance in the northern and southern counties.

LATE HATCHING.

It was noticed everywhere that the hatching of 1877 was more prolonged than usual. This was in part due to the dampness of the spring, but more to the fact that eggs had continued to be deposited much later than usual in the fall of 1876. A case reported in 1875, when a single swarm alighted (at Waterford, Dakota Co.,) on the 18th of October and deposited eggs which did not hatch until the 20th of the following June, gives an opportunity of observing how much the late deposits are behind the early ones in the time required for hatching. Eggs left late in the season in this way wintered over in a fluid condition, which often created an impression that they were rotten, but I had no difficulty in hatching such with a three weeks' warm exposure. These finally hatched in the fields, but in most cases too late to do much injury. Their final exodus from the hatching grounds was also two to three weeks later than elsewhere, and on the 8th of July, when the locusts had all acquired wings, and had entirely left the neighborhood of Glencoe, I found, a few miles farther west in Renville county, the young in about the same stage of advancement that I had seen around Mankato on the 21st of June, from one-third to two-thirds still in the pupa-stage. But in general, where injury was severe, it was only in places where the young had been numerous as early as the last week of May, and it is only in an excessively dry year, with a slender growth of grain, that the crops are likely to be badly injured by the young that hatch after the first of June.

FAILURE IN HATCHING.

Throughout a large number of counties, and perhaps throughout the whole egg-area, a certain percentage of the eggs failed to hatch. In limited areas the failure was so great as to amount to almost complete exemption from injury. It is difficult to calculate what percentage of the eggs thus failed, but there is no doubt that it was often a large one. It is the opinion of those in Nobles county who have interested themselves in observing such matters, that eggs have never been laid so thickly in that county as in 1876, but hardly a wheat field was destroyed by the young in 1877. While this is in writing I have received brief reports from nearly every locust county in Iowa. There as in Minnesota, the hatching was in many cases far less numerous than the extent of the egg-deposit had led people to apprehend, and in others the injury resulting from the great number which did hatch was much less than usual. The result is condensed by Prof. C. E. Bessey, of Ames, as follows: "In the fall of 1876 they (the locusts) laid many eggs in Central Iowa. In the spring of 1877 they hatched, but for some reason, not known to me, (nor any one else hereabouts,) they did not amount to much."

The causes of failure in hatching are generally stated to be "unknown." They are no doubt the unusual temperature and rainfall of the spring and the action of the Silky Mite and various grubs. It is precisely in those counties of Minnesota and Iowa where the locust evil has been most permanent for the last five years that the eggs have been apparently destroyed, while the territory of densest hatching and most sweeping destruction in Minnesota lies almost entirely outside of what has been the region of greatest and most continuous damage for the last five years. As the persistent cultivation of any growth is followed by a corresponding increase of its insect-enemies, so the increase of these insects is followed by multiplication of the parasites and enemies which prey upon them. The destroyers of the locust eggs, not endowed with the same efficient powers of locomotion as the locust itself, are confined to a smaller range and continue to multiply within it, and where the locust deposits eggs for a series of years within the same range, its enemies will in time multiply, rarely perhaps in sufficient numbers to overpower the locust, but sufficiently, when aided by other favorable conditions, to produce a marked diminution of the species; while to preserve the balance still further the locust carries its own enemies with itself to other laying-grounds not only in the germ of the slowly moving locust mite but of the swift Tachina Fly.

AREA OF GREATEST INJURY.

The greatest injury inflicted by the young during the spring, and in fact the area of all injury in the State worth reporting, was confined to a strip of country extending southeastward from about the centre of Otter Tail county to Lake Crystal. and lying along the edge of the timbered regions. On the east it was partly bounded by the timber, extending some little distance eastward into it in its northern part, (into Todd and Stearns counties), the hatching growing less as it progressed eastward. and finally failing almost entirely, except in open spots along the Mississippi. On the west the boundary was irregular. It was limited mostly by the line of what had been the most frequent cultivation in 1876, confined to river valleys and the points of thickest settlement, while as the farms became more scattered, (to the westward) the hatching thinned out, and finally ended almost entirely where stretches of unbroken prairie began. In general the swarms seemed to have progressed eastward (in Minnesota) in 1876 without halting to lay except in the vicinity of cultivation, and to have been checked in their progress by the timber and to have massed their forces along its edge. At any rate this region was a laying ground through the whole of the preceding season from the middle of July, through August and sometimes into September. It is difficult to convey, to one who has not seen such sights, an idea of the immense numbers of the young that appeared in some parts of this infested region in the last week of May. The wheat fields covered with the young, and sometimes trimmed bare of every green blade, the low bushes by the roadside stripped of their leaves, the young locusts dancing into the air, and flickering like heat in the sunlight before the horses' feet in a ride of miles across the prairies, the road-beds blackened with the young basking on the warm sand, all these, which had then hardly begun their devastating marches, prophesied the injury which was destined to ensue. These were extreme cases, but elsewhere, where the numbers were less, the bands which came marching over the fields, one after another, finally sufficed to make way with nearly every crop within their reach. Later on, the wheat which had been left by the young in May was trimmed of its green leaves, and the stalks were left like spindles, blackening in the sun, while the locusts having destroyed about every crop (except oats) which happened to lie in their path, trimmed out the tender portions of the prairie grass and made it almost unserviceable for grazing. The oats, the foliage of which was hardly touched, were attacked while heading out, and the slender stems of the berry cut off, but generally something of an oat crop was harvested when there was hardly anything else left to gather.

A general, but hardly an organized warfare was waged against the young almost from the outset, every man defending his own fields as best he could. In the nineteen counties which the Hon. Commissioner of Statistics reports as more or less injured, the acreage of wheat was less by 113,700 acres than in the preceding year, but was still considerable, amounting to 337,000 acres. Of these counties eight showed an increase of wheat-acreage over 1876, while, of the remaining eleven, four counties sowed from three to six-sevenths less than in the preceding year. There were instances of men who, warned by former experience, sowed nothing whatever, as well as of men who sowed as largely as though no enemy were at hand; but far the larger majority were the cases of those whose only hope of a decent subsistence depended on such a crop as they might bring through to harvest. The energy with which most of these began the battle as soon as the young made their appearance, was worthy of all success. The usual methods of burning the young were resorted to at once, and in some cases ditches were run about the fields. Towards the end of May the coal-tar pan, which had been used in various forms in Kansas, Colorado, and elsewhere, came at last (after having been fully described during the preceding year,*)

*There was no reason why the use of coal tar, kerosene, &c., in pans or otherwise should have seemed a novel or providential invention to the people of Minnesota. The use of tar spread upon building paper was fully described in the Report of the Geological and Natural History Survey of Minnesota for 1876; a full description of the kerosene pan was sent broadcast in one of the "patent insides" of our country papers for the same year; a letter from Greeley, Colorado, dated August 5th, 1876, to the Farmers Union of Minneapolis, describes the use of coal-tar spread upon canvas, to be dragged over the grain; while in the proceedings of the Grasshopper Convention at Omaha, (page 51) the same instrument was described again. In spite of all this the use of coal-tar seemed absolutely unknown to the people of Minnesota until it was make known to them by the letters of the Hon. A. B. Robbins, of Wilmar, to the St. Paul Pioneer Press in May, 1877.

to the attention of the people of Minnesota, and was seized eagerly as an instrument that promised to be effective. For the next three or four weeks, wherever tar and sheet-iron could be obtained, men, women and children dragged the tarpan industriously over the grain fields, until the instrument became either useless or unnecessary. By the middle of June the locusts had grown so large that other means of catching had to be devised, while in the majority of cases the crops were either so badly injured as to be not worth fighting for, or were so far beyond the reach of the locusts that remained that further fighting was unnecessary. It is difficult to estimate the exact amount of success to be attributed to the different methods of destruction as they were applied, or indeed to any method that has been applied so far. In a warfare of this kind the farmer must take his chances, and what proves successful in one place, or in one year, may be totally futile at another time or place. In spite of all that has been said and written for the last three years it is necessary to say here once more what most of our farmers are at last convinced of, that in strong emergencies there is no dependence to be placed upon anything but a well dug and carefully tended ditch about the fields. If properly constructed it will prove, in nine cases out of ten, an absolute barrier until the locusts acquire wings, when the element of chance comes in again. Dr. J. C. Currier, of Mankato, managed with a ditch to save entirely unharmed the crop of 160 acres, in the midst of locusts hatching out in unusual numbers, and the method, the cost, and the result of the experiment will be found in full in the report of the National Entomological Commission; upon the Barden farm near Windom it is reported that a heavy crop was saved by a diligent use of tar-pans; Mr. Robert Lowe, of Lynn township, McLeod county, in a neighborhood where the locusts hatched in great numbers, managed to save part of a crop by using the tar-pan early in the season, and later on an open-mouthed trough, dragged over the grain after nightfall. Under the date of Nov. 21st, 1877, he writes:

"The field of wheat opposite my house yielded me 20 bushels to the acre,—the part of it which I saved, which was about 10 acres. The two neighbors of mine north of me did not fight the hoppers at all, and that part of the field next to them was eaten close. I kept working at them every night, but they got a part of it before they left.

On a three-acre field south of my house, the hoppers ate about one acre of it; they came from another neighbor that did not fight them. The two acres left yielded me 25 bushels to the acre.

The two neighbors north of me, above referred to, had about 25 acres of wheat each; one of them harvested 4 bushels to the acre, the other 3½ bushels.

I had 20 acres of new land and 5 acres of old land in wheat in another place. None of the neighbors around fought them and I did not get a kernel off that. The hoppers were more than I could handle there and on that I *did* save, so I confined my operations to that I saved. One neighbor near me who *did* fight the hoppers, saved 65 bushels from about 7 acres."

On the other hand there were fields that were swept clean of grain at the very outset. The only thing that could have saved such would have been a ditch constructed before the locusts began their march. To say that such a ditch would have proved insurmountable in every case would be to assume too much, but there is no question that it would have succeeded in a large number of cases where every other defence failed.

All this refers to protection against insects hatched outside of the grain fields. There are also large extents of wheat sown upon newly broken prairie ("new-breaking,") where the eggs had been deposited in great abundance in 1876. Wherever the deposits had been left undisturbed, the growing wheat was destroyed at the outset. Even where the surface had been harrowed or broken with the seeder in the fall of 1876, the eggs left undestroyed were still numerous enough to consume the wheat as fast as it grew. Only plowing the eggs under deeply, or vigorous harrowing of the surface in the fall or spring, with the use of a tar-pan pan to catch such as hatched upon the field, together with a ditch to prevent incursions from without, might have sufficed to save such fields as these.

INJURY TO THE CROPS.

Nineteen counties are stated by the Honorable Commissioner of Statistics to have been more or less injured in 1877. These are as follows: Kandiyohi, Chippewa, Wright, Stearns, Nicollet, Pope, Douglas, Swift, Otter Tail, Stevens, Grant, Todd, Renville, Sibley, McLeod, Meeker, Yellow Medicine, Brown, Redwood. He adds: "The most careful estimates of the bushels harvested by the counties gives the following results:

Kandiyohi and Chippewa, total loss; Wright county, slightly injured; eight counties are believed to have saved half a crop; one, a third; one, a tenth; two, two-thirds; three, three-quarters; and one, four-fifths.

This was the Commissioner's estimate in October, and it is not probable that exact statistics will *add* anything to the estimated loss. Of the above counties three were probably more injured by the flying swarms than by the young. In addition to the counties named above, thirteen others were by the end of May in a state of more or less apprehension, and tar-pans were put to vigorous use. A hot, dry June like that of 1876 would have resulted not only in greater damage in the injured counties but would have added many other counties to the injured area.

The comparative temperature and rainfall for the last four years may be seen from the following table, derived from the reports of the Signal Service at St. Paul.

	Average Temperature.		Total Rain Fall in inches.		Number of days when rain fell.	
	May.	June.	May.	June.	May.	June.
1874	62.24	68.7	1.65	11.67	7	16
1875	58.81	63.6	3.06	4.33	12	17
1876	59.2	66.3	3.15	2.02	12	14
1877	62	63.7	5.43	7.13	12	13

The total rain-fall in May was considerably greater than in any of the three preceding years, while that of June was greater than for any year since 1874. The average temperatures for May and June do not differ greatly from other years, but a detailed table would show the result of weather much better than a table of averages. It would show a well distributed rain-fall, accompanied by cold days, with northeast winds. This was the character of nearly all the former half of June. The result of this in May was a more than usually prolonged hatching, as the rain coming just when the egg-pods were bursting arrested the hatching for a time, and no doubt prevented it altogether in soils that retained moisture. Eggs thus arrested were found in the latter part of May in a decayed condition, and a prey to the Anthomyia maggot. The last two weeks of May however were warm and dry, and this gave the young insects a full opportunity for destroying the grain where they were numerous. But the change of temperature early in June again arrested their progress wherever the grain had not already been badly cut off. The large number of damp, cold, and cloudy days deterred the locusts from eating, and gave the grain an opportunity to recover itself, while the temperature was exactly such as to produce the strongest and rankest growth of wheat foliage. As this sprang up apace and covered the ground, the locusts, loving warmth and sunlight could not spread through and over the fields as in a year of slender and sparse growth, while the abundance to be eaten necessarily left more which escaped untouched. In many cases the wheat in this way attained a growth which afterwards remained beyond the reach of the locust. In others the insects were abundant enough to trim off the foliage, and in the first week of July thousands of acres of wheat stood in the fields like bare spindles, the head still enclosed in the terminal leaves. Possibly a continuance of favorable weather through July would have produced something from even such fields as this, but, in the hot, dry weather which followed, the heads never filled.

But it is to favorable temperature more than all else that we are to assign not only the abundant harvest in the uninjured counties but such crops as were saved in the remainder. Those who believe that the efficacy of our prayers may be tested by the material results which follow them, can safely find a beneficent answer to the fasting and supplication of April, not in a brief snow storm that perhaps destroyed an insignificant number of locusts which would in all probability have proved harmless, but in a whole season of favoring winds and nourishing rains.

The effects of climate were seen too upon the young insects as well as upon the grain. It is to this doubtless that we are to assign the cause of the often reported disappearance of the young in the spring without committing injury, and of the harmlessness, "from causes unknown," of such as remained up to the time of flying; reports which come from Iowa oftener than from Minnesota. It is to the same cause no doubt that we are to attribute the number of locusts found dead in the fields during the spring; numbers which were very inconsiderable when compared with those which remained alive, but sufficient to show that unusual agencies were at work. To those who from limited observation believe that the species is proof against moisture, it may be asserted that a spring of a different character from the four preceding has been followed by an unusual series of locust events, viz.: comparative harmlesness of the hatching brood, a partial degeneration, and finally a total migration as if from an unnatural neighborhood; while still others are to be reminded that the State is no more a permanent breeding ground of the species, and no more likely to be, than it was some years ago.

MOVEMENTS OF THE WINGED.

Here and there a fully winged individual of Spretus may be found in our fields early in June. I noticed such on the 8th of June, 1876, and on the 14th day of June, 1877, while others were reported as early as the 26th of May. From the middle of June the number of the winged increases rapidly, and these often rise in the air singly, and float lazily along on the breeze. On the 19th of June I observed such at Mankato, as thick in the air as stars upon a moderately starry night, while upon the ground below a still greater number had developed wings, and on being disturbed would start up for a low flight of a rod or two. Here and there one would rise from the earth, and could be seen rising very gradually in the air for a long distance, until it finally became lost to sight. Neither on the ground nor in the air was there any appearance of swarming. The numbers in the air increased rapidly from day to day until the last week in June, when, as if they had begun to mass their forces, dense swarms could be seen moving slowly, high in the air, over the central portion of the State. These, though appearing to move southeast on the 26th, 27th, and 28th of June, were not seen east of what had been the hatching area. From the latter date until nearly the middle of August the State was repeatedly crossed and recrossed by immense bodies of locusts, alighting heavily and destructively in the first week of July, but only appearing high in the air, and purely as migrating swarms later on. These movements consisted generally of bodies, (rather than of one immense swarm,) seen here and there over a large area, all pursuing one general direction, and following each other for a few days until the supply seemed exhausted, when, after a change of wind, what were apparently parts of the same army, returned over their former track only to be carried back again with others when the wind changed back again. As the season advanced, the swarms making up these armies became more scattered, and followed each other at wider intervals, or were soon separated at long distances from each other.

MIGRATIONS.

These movements may be briefly summed up as follows:

July 3d–7th—A movement to the northwest by daily journeys, with heavy alighting each evening from Willmar westward to the Sisseton Reservation and beyond.

July 8th–10th—A change of wind, with a return at once to the southeast. This movement was observed at sixty points between Bramble county, D. T., and Freeborn county on the south, and between Otter Tail and Sherburne counties on the north.

July 11th and 12th—A change of wind and return of the swarms to the northwest, observed at various places between Detroit and Sioux City on the west and between Sioux City and Fort Randall, D. T.

July 20th and 21st—An immense movement to the southeast again, observed at 78 points in Minnesota and Dakota. Swarms were seen on the western line of observation, at various points between Walhalla and Rockport, D. T., 375 miles from north to south, and between Rockport and Albert Lea, on the southern line, 225 miles from east to west.

July 28—Another movement to the southeast, seen over various northern and southern counties, but not reported over a large number of intermediate points.

August 1st and 2d—Another extensive movement to the southeast. This was seen at various points between Glyndon and Luverne on the west, and at St. Cloud, Anoka, Northfield and LeRoy on the east.

Aug. 6th–9th—Heavy flights, (but decreasing in numbers daily) to the southeast again; seen mostly on a line between Benson and Mankato and Worthington.

Sept. 2d—"Large numbers" flying southeast over Waseca.

Sept. 18th—"Millions seen flying in a southeasterly direction" at Long Prairie.

There is reason to believe that, as has been known elsewhere, many of these swarms continued their flights through the night. They were observed on several occasions flying till nearly sundown, while it was impossible to learn of their alighting anywhere at or during the night; they were seen moving early in the morning as soon as the sun was high enough to make their numbers visible, while there was no known starting place from which such swarms could have proceded so early in the morning; and in one known case, (and probably in many others,) they abandoned in the night a spot where they had been abundant during the day.

It will be noticed that after the 20th of July all extensive movements were to the southward. On the dates intermediate between those given, there was a change of wind to southward, and this carried back sometimes considerable, but always scattered bodies to the northwest, while as the season advanced the number thus carried back became fewer. Those which were carried to the northwest probably helped to make up the bodies which moved southeast again as soon as the wind changed to northerly, and what may have been something like a compact army early in July were spread over a large territory later on. The change of wind between the 7th and 8th, and again between the 10th and 11th of July were followed at once by the return of swarms over the track where they had passed the day before; on the other hand it required a change of wind from the 12th to the 20th and again from the 20th to the 28th of July to collect and bring back the swarms which passed over on the latter dates. During the later movements too, straggling bands were seen at a considerable distance to the east of the main bodies, as at St. Paul on the 20th of July, on the 1st and 2d of August at Anoka, St. Paul, Northfield and Leroy, on the 6th of August at Hastings, Dundas, and Brownsdale; and during August and September over El Paso, Wisconsin, and over Osage, Grundy Centre, Toledo, and Montezuma, and perhaps over Waverly, Waterloo, Oskaloosa, and Vinton, Iowa, all of which points lie considerably to the east of the usual locust area.

All the movements after the 10th of July were purely migrations. Here and there individuals dropped down from the passing swarms until a township or two was pretty well covered, but as a rule the insects passed over without alighting. To determine the migratory capabilities and habits of the locust would be interesting and useful. During the summer I collected nearly a thousand reports, diaries, &c., to learn the extent of the flights over Minnesota. The impossibility of obtaining similar reports from Central Dakota, and the absence of such from Iowa, render it difficult to trace movements beyond the State line. The turning point of flights between the 7th and 8th of July was evidently in the neighborhood of the Sisseton Reservation; between the 10th and 11th, either in or over Iowa; about the 22d of the month the swarms collected in Dakota along the route between Bismarck and the Black Hills and these were perhaps brought southeast again on the 28th of July.

It seems probable that most of the swarms seen passed to the southward of Minnesota and remained there. It is certain that the bodies composing the different migrating armies became widely separated from each other during the season, and it is highly probable that the individuals composing these bodies were distributed over a large extent of territory and often so sparsely as to remain almost unnoticed. By the first of September the species was found at Sioux City and Fort Dodge, Iowa, in small numbers, but more numerous than the native species; still more numerous at Ackley, where they were preparing to lay; again in very small numbers at two or three stopping places along the road between Ackley and Lyle, at Lyle and at Austin; and a few days later at Lake Phalen, five miles northeast of St. Paul. It is very likely that a careful search in 1878 by those acquainted with the species will disclose the presence of the young in very small numbers at various places in Eastern Minnesota, in Wisconsin east of Hastings, and in Eastern Iowa.

The locust evil being ended for the present, all further consideration of the matter produces in the mind of the farmer only that disgust which is excited by an unpleasant subject. But the time will come again when the possibility or likelihood of locust invasions, and whether they can be anticipated or prevented will be questions of immediate interest. But to a community looking forward to years of prosperous wheat-raising, and knowing that future success depends in some measure upon exemption from various insect plagues, it should seem foolish to conclude the inquiry with that amount of knowledge which has so far been obtained. The National Entomological Commission should be enabled to pursue its investigations beyond the field where circumstances have so far confined them, into the region where the nature of the locust problem is still largely unknown,and where alone the possibilities and probabilities of future destructive incursions are to be calculated.

DISTRIBUTION.

A history of former locust invasions, and a full chronology of locust appearances in past years, whether seen in small or in great numbers, in destructive onslaughts upon the grain, or in harmless migrations to other neighborhoods, become valuable to assist in determining what are the regions of perpetual, frequent, or occasional presence. It has been common to call "locust years" only those years in which swarms have appeared in destructive numbers, and to call "locust regions" and "grasshopper counties" those only where cultivation has been sufficient to invite injury. It has often been difficult to collect such facts as there are, and the desire to appear well in immigration statistics induces men to withhold occurrences that would seem to convert their particular localities into "grasshopper regions" for the time being, but which were after all only trifling appearances of a misfortune that was felt elsewhere in full force. "Locust regions" are not created by simple statements of facts, nor are the gardens of the world depopulated by occasional locust invasions.

But a locust chronology for the past fifteen years contradicts the notion that there is anything like periodicity in the appearance of the species, though there are evidently years or periods of excessive multiplication; it also disposes of such vagaries as that the stock has been advancing eastward yearly, occupying a certain belt of country each year; or that they "move mostly in a great circle, touching Missouri on the east, and New Mexico on the south, the Pacific on the west, and far into the British Possessions on the north," the time required for swinging around this circle "being about ten years, though some get behind by being hatched out late!" It has been a locust year somewhere or other nearly every year for the last fifteen years, and swarms have repeatedly swept southward from British America perhaps to Texas, while their offspring moved back northward over the same track in the following spring. It would seem that east of what may be the permanent breeding grounds of the species, there is a region where swarms appear nearly every year, and that the permanence or frequency of appearance diminishes as we move eastward. To say that this region of frequent appearance is not a "grasshopper country," is to say for the present that it is mostly uncultivated and uninhabited, though there is no reason to believe that if it were under full cultivation that it would suffer devastation every year.

This region of frequent appearance reaches eastward nearly to Minnesota, and the frequency results from the fact that the region referred to lies in the track of swarms moving northwestward towards the mountains in the spring, southeastward from the mountains in the summer, and at the same time in the vicinity of swarms occasionally hatched upon the plains. At least it is certain that the locust has been seen either along or east of the western border of Minnesota nearly every year since 1863. At Walhalla, a few miles west of Pembina, they are said to have come one year and left in the year following ever since in the year just named; in the same year (1863,) they were about Moorhead, around the Coteau des Prairie, Ft. Abercrombie, and were seen flying as far east as the Pomme de Terre River; in 1864 the young hatched near Moorhead, and possibly in other places in the western part of the State north of the Minnesota river; while in July winged swarms from the west made their way in a narrow column up the Mississippi Valley to Le Sueur and Henderson; in 1865 the young of these were troublesome in the regions just named; in 1866, a year of serious invasion in States to the southward, there were but slight and transient appearances of swarms in Minnesota, about Moorhead, and in Redwood and Kandiyohi counties; in 1867, a year in which Iowa was overrun almost as extensively as in 1876, there was no appearance in Minnesota so far as can be ascertained; in 1868 large swarms passed northward over Jackson county for two or three days, probably those which had hatched in Iowa and the States below; in 1869 the insects were seen about Moorhead again; in 1870 about Moorhead and in Brooking Co., D. T.; in 1871 a large number of our northwestern counties were visited, but were injured only here and there; in 1872 the offspring of these augmented by others hatched in Dakota seemed to have passed southward in immense armies over Southeastern Dakota and Nebraska; the events since 1872 are too well known to need repeating.

There is nothing alarming in these statements; it is known well enough in how few of all these years the insects have poured into the State in immense swarms, and how few of all the swarms that have appeared have remained to prove destructive. It is only in a year of excessive and repeated visitation that the small numbers remaining behind from each passing cloud finally become numerous enough in the aggregate to make their presence destructive in the year following. It is only meant to show that Eastern Dakota lies in or near a region where the locust frequently appears; somewhere within yearly reaching distance of the transient or permanent breeding grounds of the locusts. On the other hand but a few miles to the east lies a region where the locust appears but rarely, while still a short distance beyond is a region where it never appears.

A line drawn from Crookston to Le Sueur, thence southward across Iowa through Fort Dodge marks nearly the general eastern limit of serious injury. In Minnesota this is nearly the dividing line between the prairie and the timber, which in Douglas and Otter Tail counties extends some thirty miles to the west of the line though not densely everywhere. From Le Sueur southward the line again coincides very nearly with the western boundary of the Big Woods, until the latter, thinning out give place to the prairie counties of Southern Minnesota and Iowa, where as the physical barriers of the forest no longer exists, the line must represent nearly the natural limits of the encroachment of the species. That there is some such natural eastern limit, coinciding nearly with the line given, is seen from the fact that the hatching swarms, on migrating, have on no occasion whatever occupied new ground to the eastward, or pursued any line of flight which would not carry them somewhere to the west of where they hatched. Whenever invasions have been carried to the east of the usual line, it has been in all cases by swarms appearing from the northwest, generally late in the season and by slow advance.

These in exceptional cases have occasioned injury or have deposited eggs in the openings to the east of the limits named, but with serious results only in 1856 in the Upper Mississippi Valley, and in Todd and Stearns counties in 1876.

To determine exactly how far east the species has hatched of late years, and to say just where it definitely ended, would have required careful examination by those acquainted with the species. It hatched in 1877 in observable numbers at least fully up to the line given upon the "Map of Locust Areas," in the report of the Geological and Natural History Survey for 1876. The hatching of the year confirmed the general correctness of this line; still more correctly it might have been drawn from Detroit to Princeton, thence southward to Austin, whence it moved southward across Iowa, passing nearly through Hardin, Story, Dallas, Madison, Adams and Taylor counties. But throughout all the eastern portion of this hatching area the young appeared in squads on scattered hatching grounds, and no doubt careful search might have found still others east of the limits given, the young of the swarms straggling eastward late in the fall, and finally disappearing, no one knew where.

It would be interesting to learn also the extreme northeastern limit of the appearance of the species. It lies somewhere in a region of woods and swamps north of the Northern Pacific and east of the longitude of Brainerd. This almost uninhabited region, though not lying in the usual line of flights, might be traversed by swarms in almost any summer and the fact remain unheard of. It is certain that locusts in years past have been seen in swarms, or in small numbers on the ground, at Red Lake, Leech Lake, Gull Lake, Brainerd, Aitken and Duluth, while several years ago locusts injured the vegetables and grass upon the island opposite Ashland, Wisconsin. All these points lie in a region which the locust is supposed to avoid. But even if it is possible for this insect to choose by instinct a certain line of flight, and to select the winds which will carry it in that general direction, it is carried at times to situations which the most trifling amount of instinct would cause it to shun, and has been found in immense numbers in the waters of Lake of the Woods, Red Lake, and in fewer numbers in Lake Superior. The northeastern limit of flight depends, partly at least, upon the point where swarms cross our border, and those coming in well to the east on the Manitoba line might, as in 1856, be carried into the Upper Mississippi Valley. The swarms of that year were no straggling bands, blown out of their course late in the season, but came in immense numbers, which by the testimony of all who remember the event, were many times more numerous than any that have appeared in later years. These reached Gull Lake and the region around it near the end of July, and not only destroyed the crops at Crow Wing and thence southward in the Upper Mississippi Valley (which has never since been injured between Crow Wing and Sauk Rapids,) but penetrated in monstrous numbers into the woods about Mille Lacs Lake where they bent down the pine branches with their weight. They penetrated in considerable numbers as far as Cambridge, Isanti Co., a point which was hardly reached by swarms of 1874, and was not visited in 1876. All those swarms of 1856 must have crossed the northern boundary well to the east, or must have turned their flight eastward over the very regions which the locust is supposed to avoid. It is also noticeable that they penetrated southward only to about the neighborhood of Shakopee.

This was an exceptional instance in some respects. and in the locust invasions which we are destined to suffer in the future, there will probably be occasional events which will seem to contradict all previous experience, and to make it impossible to lay down anything like general rules. It might happen that swarms in a long, warm, and dry autumn might pass a few miles farther east than they have ever appeared before, and leave eggs which in a following spring of excessive dryness, and with a thin growth of grain, would prove destructive to a large proportion of everything sown. For all that the species has a certain natural range, and though no line can be definitely drawn beyond which it can be predicted that the locust will never appear. the regions of habitual, frequent, and infrequent appearance will be ascertained, while there still remains the strong probability that with increase of cultivated acreage towards the mountain regions the appearance of swarms in Minnesota will become rarer than before. It may even become possible to predict the time of appearance at certain points, and to take an example, as swarms reached Sauk Rapids about Aug. 20th, 1856, Aug. 17th, 1874, and Aug. 11th and 18th, 1876; as they reached Monticello Aug. 13th to 16th, 1856, Aug. 17th, 1874, and Aug. 18th, 1876, it is not probable that they will often reach the Upper Mississippi before the middle of August, or will often prove destructive to any great distance beyond it, either in a summer of invasion or in the spring following.

Finally, if there is in future any fear that Minnesota may become a permanent breeding ground of the locust, it may be said that so far as is known there is no permanent breeding ground of the species in any strict sense of that term. The species is migratory, and until it loses this habit there is no fear that the swarm which hatch here will remain to breed by natural increase. They may remove but partially, or to a short distance only, or they may be replaced by others in the same season, but in any case the instinct, the impulse, or the chance wind which brings them upon us will eventually remove their offspring.

The reference on the 2d page of this report to damage inflicted by the Chinch Bug may be found on pp. 17 and 18 of the Report of the Commissioner of Statistics for 1877, as follows:

"The crop of 1876 was menaced by three destructive agencies. The one already mentioned—heat drouth or whatever it was; the dreadful locust, whose flickering wings filled the air in the western portions of the state from the earth to the highest point of human vision; and locally, in Houston county, the chinch bug, where considerable damage was inflicted by this new foe to our great staple.

* * * * * * the third was not of sufficient magnitude to warrant the precise ascertainment of it—but it is a dangerous and insidious foe, and doubly dangerous because it is insidious, and should the coming year be marked with their renewed attacks, they should be carefully studied and their characteristics reported."

Upon page 97 of the same report the Commissioner quoted the following letter:

CALEDONIA, HOUSTON CO, MINN.
December 10, 1877.

T. M. Metcalf, Commissioner of Statistics:

SIR:—In reply to your inquiries as to the ravages of the Chinch Bug in this county, I cannot say much.

These pests are a mystery to me, and to every one of whom I have inquired, and I have not been able to find out much about them.

They are here now; they have charged the earth with eggs ready for the hatching temperature of earliest Spring, when, I fear, our farmers here will catch it again. I learn that they are at Fountain, on the Southern Minnesota Railroad, in myriads.

It is estimated that they destroyed two-fifths of the wheat crop of this county in 1877.

The *bee theory* has been tried on them. They smell like a bed-bug, and one can detect their presence by the smell in walking through the fields. They also manifest themselves by the change in the color of the grain. Their season is when the grain is in the "milk," just before harvest.

They do no injury at all before that time.

It is said that they were here before—just at the close of the war. Some of them live in the ground, under the stools of the grain through the winter, but most of them leave their eggs and die in the fall.

They work in a small patch, and all that are in that patch get together at night in a large pile, like ants in a hill, and the boot-heel, and hot water, with aid of lanterns, are used; but this is a slow process. When they finish a small patch, they move to another part of the field.

They were not troublesome in the western part of this county, nor were there many, if any, in adjoining counties.

Very Respectfully,
Yours, &c.,
E. W. TRASK,
Auditor of Houston Co,

I have received the following letter from the same source :

DEAR SIR:—Your favor of the 19th inst. requesting information concerning chinch bugs, rye, &c, came duly. The chinch bugs promise mischief again this year in this county. They are very thick in the fields. We are a little in hopes that frequent cool showers will keep them back, and the early season ripen the grain before they do much damage. Some, not much, winter-rye is sown. The bugs do not trouble that much I am informed.

Respectfully,
E. W. TRASK,
Auditor of Houston Co.

CALEDONIA, MINN. May 22, 1878.

Crop reports in the St Paul Pioneer Press during the past month mention the presence of the chinch bug in other localities. As it may be necessary for farmers to take what precautions they can against this most dangerons insect, I here briefly digest the substance of several entomological reports upon the chinch bug, with the hope that the republication of these notes in the newspapers may add something to the knowledge of those who are not practically acquainted with it. Riley's Seventh Annual Report for the State of Missouri (pp. 19-50) describes (with figures) the insect in full, its habits natural enemies, and the best methods of contending with it. Fitch's 2d Entomological Report for the State of New York. Harris, Insects injurious to Vegetation, and Prof A. S. Packard's Report on the Locust and other Insects in the western States and Territories contain interesting and valuable information on the same subjects.

THE CHINCH BUG.

Mentioned in various agricultural and entomological reports under the scientific names of *Lygaeus Leucopterus*, *Rhyparochromus Leucopterus, Micropus Leucopterus*, *Blissus Leucopterus*.

An hemipterous (half-winged) insect of the sub-order of *Heteroptera;* emitting, like many insects to which it is related, and for some of which it is easily mistaken, a nauseous (bed-buggy) odor.

A sucking (haustellate) insect, furnished with a sharp-pointed beak, subsisting upon the juices of grasses and cereals. Found while young feeding upon the roots and afterwards upon stalks and leaves.

The adult insect is about three-twentieths of an inch in length; the body is long, blackish, and hairy; the wings and fore wings are white, while the latter have a black spot upon the middle of the edge; legs dark yellow. Some ten varieties (including one wingless) are found differing more or less in color, but in general the species may be easily distinguished by the white fore wings with the black spot upon the edge.

The adult insects pass the winter hidden about the edges of fields, "under dead leaves, under sticks of wood, under flat stones, in moss, in bunches of old dead grass, or weeds or straw, and often in cornstalks and cornshucks.—*Riley*.

These come forth in the warm spring, pair, and the female deposits her eggs, laying them from day to day for about twenty days, underground upon the roots of the plant destined for food. These are laid in clusters, and are about three one-hundredths of an inch long, and pale amber-colored. They hatch in about two weeks, and the wingless young, bright red in color, may be found around and clinging to the roots where they have been hatched. These acquire wings in about six weeks, and after pairing, produce a second brood which lives through the winter, as stated above.

The insects may be seen upon the wing at pairing time, but do not take to flight readily. Their migrations are performed mostly on foot, in the growing stages, and from one field to another.

For the purpose of destroying the adult insects in the fall and winter, and to prevent future multiplication, the corn-stalks, dry weeds, rubbish, &c., about the fields, should be burned, or these with boards, or anything under which the insects may take shelter, may be left around the fields, for the purpose of trapping them.

As the female endeavors to penetrate below the surface of the ground for the pupose of depositing her eggs about the roots of plants, rolling after seeding tends, by hardening the ground, to prevent the deposit of eggs.

Early sowing and invigorating the plant with manure tend to bring forward the crops before the young are capable of doing their greatest injury.

As Hungarian grass is a favorite food of the chinch bug, a rod or two of it sown around a field of wheat tend to keep the young occupied until the wheat is out of danger. It is also recommended to sow with each 12 bushels of winter wheat one bushel of winter rye, as the bugs will destroy the rye in preference to the wheat; or to surround or intersperse grain crops with hemp, flax, castor beans, or buckwheat. Whenever badly infested patches of grain are noticed early in the season, straw should be spread over them and burned.

The migrations of the young, on foot, are prevented by boards set on edge along fields, and smeared with tar; or by coal tar poured along on the ground; or by running along the edge of fields a furrow turned outward, in which the insects may be destroyed by dragging, burning, or in pit-holes.

Excessive moisture, (rain, etc.) are destructive to the chinch bug; hence wherever continued irrigation is possible the insects may always be destroyed while still underground.

Among the natural enemies of the chinch bug are several species of Lady Bird, the Insidious Flower Bug, and the many-Banded Robber, (of insects), and the quail, as well as (perhaps) the prairie-chicken and red-winged black-bird.

As before stated, many insects closely related to the chinch bug, having nearly the same form and smell, may be easily mistaken for it. Perhaps the most common of these is the False Chinch Bug (Nysius Destructor). [I found these in abundance (pairing) around Monticello, June 14, in cornstubble and around purslane; they were mistaken for the chinch bug by those who had seen the latter repeatedly].

The chinch bug is a southern rather than a northern species of insect, but it has been found in Wisconsin considerably farther north than in Minnesota, and Prof Packard has found it in Maine and on the summit of Mount Washington. He infers that it is found in the colder as well as warmer portions of New England, and adds. "It probably inhabits the entire United States east of longitude 100°, and will probably occur in the western Territories, wherever wheat is raised, though perhaps the altitude and peculiar climatic features of the Rocky Mountain Plateau may prevent its rapid and undue increase."

It has years of excessive multiplication, like the locust, and other insects. In 1864 it was exceedingly destructive in the Mississippi Valley. In 1868 it did considerable damage in Southern Illinois and Southwestern Missouri. In 1871 and 1874 it was again very destructive—in the former year the losses were estimated at thirty, and in the latter at sixty million dollars, the losses in Missouri alone amounting to ninteen millions. (Riley). In such years as these its control passes beyond the hands of man, and it is only possible to mitigate its ravages to some extent, by earnest and united efforts.

Respectfully submitted,

ALLEN WHITMAN.

XI.

ORNITHOLOGY.

REPORT OF DR. P. L. HATCH.

Prof. N. H. Winchell:

DEAR SIR :—In accordance with your request I have the pleasure to report a satisfactory advancement of the ornithological survey of the State during the past year. Personally, and through the assistance of competent observers, representative localities remote from the settlements have received special attention, particularly those embracing water-courses, and heavily timbered districts. Many important facts pertaining to the migration, distribution, feeding, and breeding of some species about which hitherto very little has been known, have been obtained which will be valuable in the further prosecution of the survey. Another of these facts, notably, is the intermixture of varietal forms representing different avi-faunal provinces. The western borders of the State have long been known to be interchangeable grounds, but it appears that most other portions partake of the same characteristics. I merely allude to these things to indicate to you some features of the work to be accomplished. If it were only the listing of species found to be what is commonly called *resident birds*, my previous work, together with my co-laborers in the Minnesota Academy of Natural Sciences, would leave comparatively little to be done. But it embraces the largest measure of attainable data in everything pertaining to the esthetic and economic relationships of the birds to the commonwealth.

To accomplish so much, or to approximate it necessitates the employment of all available aid and considerable time. I regard myself highly favored in having the co-operation of several competent collectors in the different sections of the State and especially a number of young men residing in this city. They have already contributed notes on the habits of some rare species that are of great value which will appear in my final report, when each will be duly accredited with all that he has done.

With this abbreviated general statement of what I have accomplished during the year, reserving details for a final report, I remain

Yours respectfully,

P. L. HATCH.

818 Nicollet Avenue, Minneapolis, May 1, 1878.

XII.

RAILROAD ELEVATIONS.

BY E. S. ALEXANDER.

ELEVATION on the Hutchinson branch of the Minneapolis and Northwestern Railway—Commencing 11.6 miles west of Minneapolis, on the line of M. & St. L. Railway, thence westward through counties of Hennepin, Carver and McLeod, to Hutchinson—from notes of preliminary survey made in November, 1877.

Miles from St. P.&P. Ry Depot.		Elevation above Ocean.
11.6	Island Lake (M. & St. L. railway track)	893
"	" " (surface of water)	881
12.2		903
13.4	Town-line between Eden Prairie and Minnetonka townships 1½ miles east of northwest corner of E. P. township (ground)	842
	Bottom of Purgatory creek	838
15.6	Town-line, Minnetonka and Excelsior townships, ½ mile north of township corner (ground)	881
15.8	Opposite north end of Silvine or German Lake (water—about)	881
16.9	Summit of ridge between Silvine and Christmas lakes	978
17.1	Ridge south of Christmas Lake	997
	Christmas Lake (water—about)	920
18.2	Lake Lucy (ground)	945
	" " (water)	943
19.3	On west line of section 3 near ¼ corner Chanhassan township. This is on a narrow ridge 15 feet above the tamarack swamp on west, and 20 feet above tamarack swamp on east; the hills on each side are sixty or seventy feet higher than the swamp	989
20.0	Minnewashta Lake (water)	934
20.7	North line of Chanhassen township, in front of school house No. 59	972
21.8	Virginia Lake (water)	919
22.7	Outlet of Virginia Lake—head of Lake Minnetonka—old site of Smithtown (water of Minnetonka)	917
	From here the line follows around the south side of Lake Minnetonka and Halsted's bay to 26.2 miles. Bluffs are from 80 to 100ft. high.	

Miles from St. P.&P. Depot.		Elevation above Ocean.
26.5	Ridge between Six-mile creek and Halsted's bay....................	943
26.6	Marsh of Six-mile creek..	919
26.7	Six-Mile creek (bottom)..	913
28.8	500 feet north of the center of section 20, Minnetrista township—outlet of large cranberry marsh....................................	973
29.2	Watershed between Lake Minnetonka and Crow river..................	981
31.3 to 32.2	On south edge of Picture or Mud Lake (water)........................	929
32.2	Center of section 14, Watertown township................................	931
33.3		983
35.1	Crow River (bluff on east side)..	965
35.8	" " (Watertown mill-dam)................................	916
	" " (bottom of river)..	910
36.7	1,900 feet north of southwest corner of section 8, Watertown Tp., (grassy swamp)..	926
39.9		981
43.0	Ocean Marsh (grassy marsh)..	988
43.9	County-line between Carver county and McLeod..........................	1,014
44.4	Outlet of Winsted Lake [dry bottom]......................................	981
44.6	Winsted Lake, south side [top of bluff]..................................	1,003
	" " [water]..	985
46.9		1,026
48.7		1,029
49.7		1,048
52.0		1,040
54.0	1,400 feet west of the southeast eorner of section 28 in Hale township—half mile north of Silver Lake post-office..........................	1,051
55.3		1,074
56.0	Swan Lake [water]..	1,036
56.4		1,066
57.5	Bear creek..	1,037
58.6	Leave Big Woods and enter the rolling prairie..........................	1,058
61.7	Crow River [bluff]...	1,068
62.1	" " [water]...	1,020
	" " [bottom]...	1,017
62.4	Hutchinson..	1,033

The above levels do not give a correct idea of the nature of the country—which is very rough as far as Watertown.

From 12.5 miles to 15.8 miles the line follows the valley of Purgatory Creek, whose bluffs roll back to a height of about 70 feet in quarter of a mile.

At 17.0 miles the line crosses a ridge which runs northeasterly and southwesterly. This ridge, compressed to a width at the base of 500 or 600 feet between lakes Silvine and Christmas, widens out both southwest and northeast. It prevents Lake Minnetonka from draining into Purgatory creek—although that valley is nearly forty feet lower than the lake—and flowing thence into the Minnesota river.

The bluffs on Lake Minnetonka rise abruptly to hight of about 80 feet, and a few hundred feet back are 100 feet above the lake. The line runs around on the foot of the bluffs.

From Six Mile creek the line follows up a small valley to 29.2 miles where it crosses the watershed. At this place there are hills on each side which must be 80 feet higher.

From here it follows down a small ravine between high hills to Picture Lake. On the north, south, and northeast sides of this lake the hills rise abruptly about one hundred feet.

From here to Watertown the country is not so broken.

From 36.5 miles the line follows up a small valley—whose bluffs are about 40 feet high—to 39.9 miles.

From this point to Hutchinson the general level of the country is very well shown by the table. It is rich and rolling, the knolls rise ten, twenty, and sometimes thirty feet above the depressions.

[The red hardpan drift, in a modified condition, extends *via* Hopkins Station, past the east end of Lake Minnetonka, and to within perhaps five or six miles of Excelsior. The drift knolls that seem to extend in a nearly continuous series along the south side of the Lake Minnetonka consist of this red drift. There are occasional places of sandy surface, and others of red loam, but the most of the surface is of a red gravelly loam that seems to be derived from a slight mixing of the gravelly sub-soil with a thin loam that probably corresponds to the loess loam of further east. On these knolls the soil is the same, but is much thinner, or almost destitute of loam.

On the road to Wayzata, from Minneapolis, the red drift continues to the Half-way House about seven miles from Minneapolis. Thence westward, along the north side of Lake Minnetonka, the surface is one of gray hardpan. N. H. W.]

XIII.

REPORT ON THE GENERAL MUSEUM,

CONTAINING THE COLLECTIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY FOR THE YEAR 1877.

By N. H. Winchell, Curator.

The principal work during the year has been the opening, cataloguing, and placing on exhibition of the Kunz collection of minerals. On the completion of the twelve cases designed for minerals and fossils, which are constructed on the plan of similar cases in the Smithsonian Institution at Washington, these specimens were deposited therein. They were subsequently re-handled and neatly labeled with a form of printed label. In the same cases have been placed a part of the fossils of the Trenton formation which have been studied. The duplicates of the species of the Kunz collection, which constitute nearly one-half of its bulk, have also been examined, recorded in the register, and re-boxed. They will shortly be offered for exchange, ard in that way will serve to increase the number of species in the Museum.

The *Megatherium* skeleton, a part of the collection purchased of H. A. Ward several years ago, was unboxed for the first time since its delivery at the University, in the summer of 1877, and carried to the north room of the Museum preparatory to mounting. Unavoidable circumstances, much to be regretted, have delayed this to the present, and the room, on the floor of which it is spread out, has necessarily been closed to promiscuous admission of the public, though interested visitors have been admitted on application.

Two other upright cases have also been built in the north room, uniform with those reported last year, designed for the exhibition of birds, thus furnishing the walls of the room with all the cases they will accommodate. In one of these cases Mr. Herrick has placed a number of our native birds, tastefully and naturally mounted, and arranged on artificial supports. The ornithological observations of Mr. Herrick during the year have been reported to Dr. Hatch, for use in preparing a final report on the ornithology of the State.

In addition to the birds added to the Museum, a number of plant-specimens have been preserved by Mr. Herrick; and others have been presented by Mr. B. Juni.

The fossils collected from the Trenton limestone at Minneapolis are mostly entered in the Register, though as yet unstudied.

A collection of marine specimens from the coast of Virginia was presented by Ex-Governor Horace Austin, comprising the following species:

1. Flying Gurnard. *Perinothus* (sp?)........................1 specimen.
2. Weak Fish. *Otolithus regalis. Cuv. and Val.*..............1 specimen.
3. Toad Fish. *Batrachus tau. Linn*........................1 specimen.
4. Perch. *Perca* (sp?)..................................3 specimens.
5. Fiddler crab. *Gelasimus vocans. Milne Ed*................1 specimen.
6. Crap. *Lupa* (sp?)....................................5 specimens.
7. *Brachyuran crustaceans*................................3 specimens.
8. Sea Urchin. *Echinus* (sp?)..............................2 specimens.
9. Brittle Star. *Ophiura* (sp?)............................1 specimen.
10. Star Fish. *Asterias* (sp?).............................2 specimens.

These have been placed in suitable bottles in alcohol, and form, together with other specimens collected in the Custer Expedition to the Black Hills in 1874, and others preserved last year, the nucleus of a collection of the invertebrate and lower vertebrate animals which will be of much interest.

A specimen of the so-called Jack Rabbit was obtained at Lake Shetek in Murray county, where was also found the common eastern species. This is probably nearly on the eastern limit of the range of the Jack Rabbit. A few skulls are mounted on suitable pedestals, viz.: *Ovis*, *Canis*, and *Felis*, to which others will be added.

The following catalogue shows the name, number, and source of the geological and mineralogical specimens added during the year, exclusive of the collection of several boxes in the prosecution of the field work of the Geological Survey, and only so far as the same have been examined and labeled.

CATALOGUE OF SPECIMENS REGISTERED

in the General Museum in 1877.

Serial Number.	Obtained.		Name.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
90	....	Dr. Stoneman.....	Asaphus extans. H. Compare 399............	1	....	Trenton...	Has tuberculated surface in- [stead of lamellose.
172	Oct. 1872	Geol. Sur..........	Block with schizocrinus nodosus. H. Murchisonia; sp. ? and the head of a trilobite....	1	Pleasant Grove, Olm Co.	" ..	N. H. Winchell................
185	1875.	"	Slabs containing Strophomena. (Specimens. Orthis Chetætes *et al*........	1	Fillmore Co............	" ..	" ....
186	"	"	Orthis perveta. Con. (Larger than the type.	4	Fount'n in Fillmore Co.	" ..	" (Taylor's Quarry)
189	"	"	Fragments of Asaphus gigas. H.............	1	Fillmore County........	" ..	N. H. Winchell................
191	"	"	Slab with Leptaena sericea. Sow. Orthis emacerata. H. Strophomena filitexta. H. Strophomena nitens. Bill................	1	" "	" ..	" ....
192	"	"	Slab with Poteritcrinites caduceus. H. Orthis testudinaria. Dal. Rhynchonella capax. Con. Chaetetes Lycoperdon. H. Leptæna sericea. Sow.....................	1	" "	" ..	" (The Potteriocrinus-Dendocrinus C. according to Miller.
194	"	"	Part of buckler of Asaphus gigas...............	1	" "	" ..	N. H. Winchell.................
197	"	"	Orthoceras laqueatum. H. ?..................	1	Spring Valley...	" ..	" (Com. 214.)......
208	"	"	Strophomena tenuistriata. (?)...........	1	Sec. 17, Roch't'r, Olm Co.	Galena....	M. W. Harrington, (Garirick's quarry,) Compare 311, 204.)
214	"	P. W. Thayer, Geol. Survey....	Orthis testudinaria. Dal. Murchisonia bicincta. H. Orthoceras laqueatum. H. Leptæna sericea. Sow. Bellerophon bilobatus. Sow. Strophomena nitens. Bill. Rhynchonella capax. Con.................	1	Spring Valley, Fill. Co.	Trenton...	N. H. Winchell.................
228	Oct. 1875	Geol. Sur..........	Leptæna serica. Sow...........................	1	Fillmore Co............	" ..	" ....

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
242	Oct. 1875.	Geo. Sur.	Cyrtoceras arcuatum. Hall	2	Holden, Goodhue Co.	Trenton	N. H. Winchell
243	"	" "	Oncoceras constrictum. Hall	1	" "	"	"
244	"	" "	Asaphus gigas. H. (Left maxillary portion, or cheek.)	1	" "	"	"
245	"	" "	Fragments of Asaphus gigas. Hall	3	" "	"	"
252	July, 1875	" "	Orthoceras vertebrale. Hall	1	" "	"	"
254	Oct. 1875	" "	Receptaculites	1	Lime City, Fillmore Co.	"	"
258	"	" "	Cyrtoceras ? sp. ?	3	" "	"	"
264	Sept. 1875	" "	Slabs with Strophemena and Orthis	2	Olmsted Co	"	"
269	"	" "	Orthis subquadrata. Hall	1	Sec. 30, Forestville Fill	"	"
279	Oct. 1875	" "	Orthis. n. sp	1	Minneapolis. [more Co.	"	" Same as 648, 346.
293	Sept. 1875	" "	Strophomena fluctuosa. Bill	1	Mantorville, Dodge Co.	Galena	M. W. Harrington, (Upper layers Wilson's quarry.)
294	"	" "	Graptolithus scalaris. Linn	1	" "	"	M. W. Harrington, (Upper layers Wilson's quarry.)
295	"	" "	Graptolithus. ?	1	" "	"	M. W. Harrington, (Upper layers Wilson's quarry.)
296	"	" "	Discina Pelopea. Bill. (263.)	1	" " [more Co.	"	M. W. Harrington, (Upper layers Wilson's quarry.)
307	Oct. 1875	" "	Chætetes petropolitanus, Pander ?	1	Sec. 21, Forestville, Fill-	Trenton	N. H. Winchell
321	"	" "	Orthis. n. sp	2	Minneapolis	"	"
322	"	" "	Orthis perveta. Con	1	"	"	" Different form
323	"	" "	Rhynchonella capax. Con	3	"	"	" " "
324	"	" "	" " "	5	"	"	" " "
325	"	" "	" " "	2	"	"	" " "
326	"	" "	" " "	1	"	"	" " "
327	"	" "	Orthis emacerata. H. var. multisecta. James.	1	"	"	"

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality	Formation	Collector and Remarks.
328	Oct. 1875.	Geol. Sur.........	Rhynchonella capax. Con. (v. 220)............	1	Minneapolis...........	Trenton...	N. H. Winchell, Different form.
331	1873	“ “	“ “ “	6	Minneap'lis,Finn'sGlen	“ ...	“ Different form..
334	“	“ “	Crinoid joints—(Schizocrinus nodusus H.)......	4	“ “ “	“ ...	“ ....
335	“	“ “	Crytolites compressus. Con....................	1	“ “ “	“ ...	“ ....
336	“	“ “	Orthis, n. sp..................................	1	“ “ “	“ ...	“ ....
339	1872	“ “	Orthis, n. sp..................................	4 s'bs	Rochester, Olmsted Co.	“ ...	N. H. Winchell—Whitcomb's Quarry, same as 346, 279, 648.
346	“	“ “	Orthis, n. sp..................................	3	“ “ “	“ ...	N. H. Winchell, same as 279, 648.
347	“	“ “	Schizocrinus nodosus, H. (Stem).............	1	Sec. 16, Pleasant Grove.	“ ...	“ ....
348	“	“ “	Cyrtolites compressus. Con....................	1	“ “ “	“ ...	“ ....
350	“	“ “	Orthoceras strigatum. H.......................	1	“ “ “	“ ...	“ ....
351	“	“ “	Slab containing chætetes Lycoperdon. H......	1	Pettit's Mill...........	“ ...	“ ....
352	“	“ “	Oncoceras constrictum. H.....................	1	Pleasant Grove.........	“ ...	“ ....
356	“	“ “	Strophomena. (sp. undistinguishable).........	1	“ “	“ ...	“ This shell is also found at Mantorville.
371	“	“ “	“ (tennistriata? v. No. 204 and 208.	1	NrRochester,Olmst'dCo	Galena...	“
374	“	“ “	Orthis..	12	St. Charles.......	Trenton...	“
376	“	“ “	Asaphus gigas. H..............................	1	“	“ ...	“ ....
879	“	“ “	Orthoceras vertebrale. H......................	1	“	“ ...	“ ....
381	“	“ “	Orthoceras strigatum. H.......................	2	Pleasant Grove,Olm.Co.	“ ...	“ ....
392	Oct. 1872.	“ “	Block with fragment of Orthis bella-rugosa.Con.	1	St. Charles.............	“ ...	“ ....
395	“	“ “	Orthis..	1	Rochester, Olmsted Co.	“ ...	“ Same as 652.
399	1872	W. D. Hurlbut....	Asaphus extans. H. (?) v. 90..................	1	Trenton Falls, N. Y....	“ ...	“ Has a pustulated instead of a lamellose surface.
410	Oct. 1872.	Geol. Sur.........	Asaphus gigas. H. and Strophomena filitexta.H	1	St. Charles.............	“ ...	N. H. Winchell.
429	Oct. 1875.	“ “	Orthis. n. sp.?................................	2	Spring Valley..........	Galena?...	N. H. Winchell, (ventral valve is the most convex and hence cannot be Orth's occidentalis, v. Pal. Ohio vol. I. p. 96. The plications are also too coarse.

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
635	Nov. 1876	Centennial Exb...	Volcanic Scoria	m'y	Kilauea, Sandwich Isl.		
636	"	" "	" " Pele's Hair	1	" " "		
637	Aug. 1873	Geol. Sur	Kaoline (green and impure)	1	Birch Coolie, Minn		Cut in rectangular block
638	"	"	" " "	1	" " "		Natural specimen
639	Nov. 1876	Centennial Exb...	Lava tears	2	Kilauea, Sandwich Ils.		
640	Oct. 1872	Geol. Survey	Limonite (after Pyrite)	1	Sugar Loaf, Winona	Low. Mag.	Surface specimen
641	Nov. 1876	Centennial Exb...	Water Crystals. (Quartz.)	4	Little Falls, N. Y.		
642	Oct. 1875	Geol. Sur	Orthis. n. sp?	2	Spring Valley	Galena	N. H. Winchell
643	"	"	Orthis	2	Minneapolis	Trenton	"
644	Aug. 1875	"	Orthis	4	Fountain, Fillmore Co.	"	" (Taylor's Quarry.)
645	"	"	Lingula quadrata. Eich	1	" " "	"	" " "
646	"	"	Chætetes Lycoperdon. H	9	" " "	"	" " "
647	"	"	Strophomena filitexta. H. Pal. vol. I, p. 82 (one ventral valve	1	" " "	"	" " "
648	"	"	Orthis. n. sp?	1	" " "	"	N. H. Winchell, same as 279, 346.
649	Sept. 1875	"		Indf	Olmsted Co	"	M. W. Harrington
650	?	"	Rhynchonella capax. Con	1	?		?
651	Aug. 1875	"	Orthis. n. sp	1	Fountain, Fillmore Co	Trenton	N. H. Winchell
652	1872	"	Slabs with Asaphus gigas H. Orthis testudinaria, Dal. and a small Rhynchonellas, also a Gasterosod	bks 6	Rochester, Olmsted Co.	"	"
653	July 1877	"	Cyrtolites compressus. Con	6	Minneapolis	"	C. L. Herrick
654	1873	"	Ceraurus vigilans H	1	Finn's Glen	"	N. H. Winchell
655	Oct. 1872	"	Leptaena sericea. Sow	1	Petit's Mill	"	"
656	"	"	Schizocrinus nodosus, H	1	"	"	"
657	"	"	Slab with Rhynchonella capax, Con. and Strophomena alternata. H. and Bellerophon lilobatus, H	1	"	"	"
658	"	"	Calcareous tufa	1	Minneapolis		C. L. Herrick

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
659	1872	Geol. Sur	Atrypa recurvirostra. H .... Blocks	6	Rochester, Minn	Trenton	N. H. Winchell
660	"	"	Atrypa recurvirostra. H	Indf	" "	"	" (taken from 659.)
661	Oct. 1872	"	Endoceras proteiforme. var. lineolatum. H	1	Pleasant Grove, (sec. 16)	"	"
662	"	"	Orthoceras junceum. H	1	" "	"	"
663	"	"	Cytoceras annulatum. H. and Orthoceras strig. H	1	" "	"	"
664	Aug. 1877	"	Petraia corniculum. H	Indf	Minneapolis	"	C. L. Herrick
665	"	"		2	"	"	"
666	"	"		Indf	"	"	"
667	"	"		1	"	"	"
668	"	"		1	"	"	"
669	"	"		14	"	"	"
670	"	"		7	"	"	"
671	"	"		2	"	"	"
672	"	"		1	"	"	"
673	"	"		1	"	"	"
674	"	"		9	"	"	"
675	"	"		4	"	"	"
676	"	"		1	"	"	"
677	"	"		2	"	"	"
678	"	"		2	"	"	"
679	"	"		2	"	"	"
680	"	"		1	"	"	"
681	"	"		1	"	"	"
682	"	"		1	"	"	"
683	"	"		12	"	"	"
684	"	"		1	"	"	"
685	"	"		1	"	"	"

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
686	Aug. 1877	Geol. Sur.		1	Minneapolis	Trenton	C. L. Herrick
687	"	"		3	"	"	"
688	"	"		1	"	"	"
689	"	"		1	"	"	"
600	"	"		1	"	"	"
691	"	"		1	"	"	"
692	"	"		4	"	"	"
693	"	"		1	"	"	"
695	"	"		1	"	"	"
696	"	"		2	"	"	"
697	"	"		2	"	"	"
668	"	"		1	"	"	"
699	"	"		4	"	"	"
700	"	"		1	"	"	"
701	"	"		5	"	"	"
702	"	"		2	"	"	"
703	"	"		2	"	"	"
704	"	"		1	"	"	"
705	"	"		7	"	"	"
706	"	"		1	"	"	"
707	"	"		2	"	"	"
708	"	"		3	"	"	"
708	"	"		1	"	"	"
709	"	"		1	"	"	"
710	"	"		1	"	"	"
711	"	"		1	"	"	"
712	"	"		1	"	"	" (Green slade.)

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Seiral Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
713	Aug. 1877	Geol. Sur		2	Minneapolis	Trenton	C. L. Herrick (Green shale)
714	"	"		1	"	"	" " "
715	"	"		1	"	"	"
716	"	"		6	"	"	" (Green shale)
717	"	"		1	"	"	" " "
718	"	"		1	"	"	"
719	"	"		1	"	"	"
720	"	"		2	"	"	"
721	"	"		2	"	"	"
722	"	"		1	"	"	"
723	"	"		1	"	"	"
724	"	"		1	"	"	"
725	"	"		1	"	"	"
726	"	"		1	"	"	"
727	"	"		1	"	"	"
728	"	"		1	"	"	"
729	"	"		1	"	"	"
730	"	"		1	"	"	"
731	"	"		1	"	"	"
732	"	"		1	"	"	" (Green shale.)
733	"	"		2	"	"	" " "
734	"	"		Indf	"	"	" " "
735	"	"		2	"	"	" " "
736	"	"		2	"	"	" " "
737	"	"		Indf	"	"	" " "
738	"	"		"	"	"	Fragment of above "
739	"	"		1	"	"	" " "

Catalogue of Specimens Rigistered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
740	Aug. 1877	Geol. Sur		2	Minneapolis	Trenton	C. L. Herrick
741	"	"		1	"	"	" (Green shale.)
742	"	"		3	"	"	" " "
743	"	"		1	"	"	"
744	"	"		3	"	"	"
745	"	"		1	"	"	"
746	"	"		1	"	"	"
747	"	"		1	"	"	"
748	"	"		2	"	"	"
749	"	"		1	"	"	"
750	"	"		1	"	"	"
751	"	"		1	"	"	"
752	"	"		1	"	"	"
753	"	"		5	"	"	"
754	"	"		Indf	"	"	" (Green shale.)
755	"	"		"	"	"	"
756	"	"		1	"	"	"
757	Fall, 1876	"		1	"	"	N. H. Winchell
758	"	"		1	"	"	"
759	"	"		1	"	"	"
760	"	"		1	"	"	"
761	"	"		1	"	"	"
762	"	"		1	"	"	"
763	"	"		1	"	"	"
764	"	"		1	"	"	"
765	"	"		1	"	"	"
766	Aug. 1877	"		Indf	"	"	C. L. Herrick

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formotion	Collector and Remarks.
	When.	Whence.					
767	Aug. 1877	Geol. Sur.		5	Minneapolis	Trenton	C. L. Herrick
768	"	"		2	"	"	"
769	"	"		2	"	"	"
770	"	"		1	"	"	"
771	"	"		1	"	"	"
772	"	"		1	"	"	"
773	"	"		Indf	"	"	"
784	"	"		4	"	"	"
775	"	"		1	"	"	"
786	"	"		1	"	"	"
777	"	"		1	"		"
778	"	"		1	"		"
779	"	"		1	"		"
780	"	"		1	"		"
781	"	"		1	"		"
782	"	"		1	"		"
783	"	"		1	"		"
784	"	"		1	"		"
785	"	"		1	"		"
786	"	"		2	"		"
787	"	"		3	"		" (Green shale.)
788	"	"		1	"		"
782	"	"		1	"		" (Green shale.)
790	"	"		2	"		" " "
791	"	"		1	"		" " "
792	"	"		3	"		" " "
793	"	"		1	"		" " "

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
794	Aug. 1877	Geol. Sur.		2	Minneapolis		C. L. Herrick, (Green shale.)
795	"	"		1	"		"
796	"	"		1	"		" (Green shale.)
797	"	"		Indf	"		" " "
798	Jan. 1876	Minn. Disk Co.	Serpentine. (Precious)	3	Newburyport, Mass.		
799	Nov. 1876	Cent. Exp.	Graphite	2	Rockingham, Ont		Geol.Sur.of Can.(A.R.C.Selwyn)
800	"	"	Chalcopyrite	1	Almador Co., Cal		N. H. Winchell
801	?	A. D. Roe	Dipyre		Canaan, Conn		
802	Sept. 1873	Geol. Sur.	Gypsum, (Selenite—Crystals)	Indf	Big Stone Lake, Minn.	Cretaceo's	N. H. Winchell
803	Sept. 1875	"	Ankerite	1	Lanesboro, Minn	St. Lawrc'e	
804	Dec. 1877	A. K. Ridenour	Modiolopsis pholadiformis. F. & W.	1	Oxford, Ohio	Low Sil	
805	"	"	Rhynchonella perlamellosa. Whit	2	Clarksville, Ohio	"	
806	"	"	Ambonychia radiata. Hall	1	Cincinnati, Ohio	"	
807	"	"	Avicula corrugata. James	1	"	"	
808	"	"	Orthis testudinaria. Dal	13	"	"	
809	"	"	Orthis retrorsa. Sal	1	Oxford, O.	"	
810	"	"	Orthis dentata. Pander	2	Cincinnati, O.	"	
811	"	"	Strophomena loxorhytis. Meek	2	"	"	
812	"	"	Lingula Covingtonensis. Hall. and Whit.	1	"	"	
813	"	"	Orthis subquadrata. Hall	2	Clarksville, O.	"	
814	"	"	Crania scabiosa. Hall	3	Cincinnati, O.	"	
815	"	"	Orthodesma contracta. Hall	1	"	"	
816	"	"	Orthis fissicosta. Hall	2	"	"	
817	"	"	Modiolopsis modiolaris. Con	2	"	"	
818	"	"	Orthis lynx. Eich	1	"	"	
819	"	"	Anodontopsis Milleri. Meek	2	Versailles, Ind.	"	
820	"	"	Orthis occidentalis. Hall	1	Cincinnati, O.	"	

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
821	Dec. 1877	A. K. Ridenour	Streptorhynchus elongata. James	2	Clarksville, O	Low. Sil	
822	"	"	Orthis acutilirata. Con	2	"	"	
823	"	"	Strophomena rhomboidalis. Sow	2	"	"	
824	"	"	Strophomena alternata. Hall	2	"	"	
825	"	"	Modiolopsis anodontoides. Con	1	"	"	
826	"	"	Rhynchonella capax. Con	4	"	"	
827	"	"	Orthis biforata. Eich	4	Cincinnati, O	"	
828	"	"	Tellinomya pectenculoides. Hall	3	"	"	
829	"	"	Streptorhynchus planumbona. Hall	2	Clarksville, O	"	
830	"	"	Zygospira modesta. Say	5	Cincinnati, O	"	
831	"	"	Leptæna sericea. Sow	8	"	"	
832	"	"	Streptorhynchus sinuata. Em	2	Clarksville, O	"	
833	"	"	Orthodonta parallela. Hall	1	Cincinnati, O	"	
834	"	"	Streptorhynchus planoconexa. Hall	2	"	"	
835	"	"	Streptorhynchus subtenta. Con	1	Clarksville, O	"	
836	"	"	Trematis multipunctata. Hall	4	Cincinnati, O	"	
837	"	"	Murchisonia bicincta. Hall	4	"	"	
838	"	"	Orthis borealis. Bill	2	Frankfort, Ky	"	
839	"	"	Streptorhynchus sulcata. DeVer	3	Clarksville, O	"	
840	"	"	Zygospira Cincinnatiensis. James	9	Cincinnati, O	"	
841	"	"	Strophomena squamula. James	3	"	"	
842	"	"	Orthis insculpta. Con	3	Clarksville, O	"	
843	"	"	Schizocrania filosa. Hall	1	Cincinnati, O	"	
844	"	"	Tellinomya lavata. Hall	1	"	"	
845	"	"	Orthis plicatella. Hall	6	"	"	
846	"	"	Raphistoma lenticularis. Sow	3	"	"	
847	"	"	Orthis ella. Hall	4	"	"	

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimen.	Locality.	Formation	Collector and Remarks.
848	Dec. 1877	A. K. Ridenour	Orthis Jamesi. Hall	4	Cincinnati, O.	Low Sil.	
849	"	"	Nucleospira fusiformis. Hall	2	Morrow, O.	"	
850	"	"	Orthis emacerata. Hall	4	Cincinnati, O.	"	
851	"	"	Tellinomya obliqua	4	Ohio	"	
852	"	"	Cleidophorus fabula	3	Ohio,	"	
853	"	"	Avicula insueta. Con	2	Ohio	"	
901	Nov. 1876	Geo. F. Kunz	Bog Iron ore No. 1	1	Bulau bei Hanau		
902	"	"	Freshwater limestone No. 2	1	Binau		
903	"	"	Loess No. 3	1	Heidelberg	Loess	
904	"	"	Limestone No. 4	1	Naples, Italy		
905	"	"	Tertiary sandstone No. 5	1	Heppenheim	Tertiary	
906	"	"	Molasse No. 6	1	Bern, Switzerland		
907	"	"	Calcareous Conglomerate No. 7	1	Rigi, Switzerland		
908	"	"	Sandstone No. 8	1	Siebengebirge		
909	"	"	Platic Clay No. 9	1	Hemsbach		
910	"	"	Porcelain Jasper No. 10	1	Bilin, Bohemia		
911	"	"	Brown Coal No. 11	1	Teplitz, Bohemia		
912	"	"	Lignite No. 12	1	Salzhausen, Wetterau		
913	"	"	Freshwater Limestone No. 13	1	Stubenthal, Wurtmbu'g		
914	"	"	Tegelkalk No. 14	1	Frankfort-on-the-Main		
915	"	"	Tegelkalk No. 15	1	Wusenau bei Mainz.		
916	"	"	Tripoli Slate No. 16	1	Bilin, Bohemia		
917	"	"	Tile or Brick Earth No. 17	1	Near Vienna		
918	"	"	Calcaire Grossier No. 18	....	Vangirard. France		
919	"	"	Klebschiefer No. 19	....	Montmartre, France		
920	"	"	Gypsum No. 20	....	Montmartre, France		
921	"	"	Flysch No. 21	....	Bern, Switzerland		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
922	Nov. 1876	Geo. F. Kuntz	Nummulitic Limestone No. 22	1	Kressenberg, Bavaria		
923	"	"	Foraminifera Limestone No. 23	1	Bavaria		
924	"	"	Upper Chalk No. 24	1	Maestricht, Holland		
925	"	"	Chalk No. 25	1	Denmark		
926	"	"	Limestone No. 26	1	Gossau Alps, Austria		
927	"	"	Glanconitic Chalk No. 27	1	Rouen, France		
928	"	"	"Planer" Limestone No. 28	1	Teplitz, Bohemia		
929	"	"	"Quader" Sandstone No. 29	1	Pyrna, Saxony		
930	"	"	Gault No. 30	1	Gyl Evegne, France		
931	"	"	Wælderthon No. 31	1	Niederschœna, Saxony		
932	"	"	Wælderthon No. 32	1	Santel		
933	"	"	Hastings Sandstone No. 33	1	Bredenbeck		
934	"	"	Lithographic Slate No. 34	1	Solenhofen, Bavaria		
935	"	"	Coralline Limestone No. 35	1	Istein, Baden		
936	"	"	Jura Limestone No. 36	1	Kandern, Baden		
937	"	"	Oxford Clay No. 37	1	Dives, France		
838	"	"	Ornatenthon No. 38	1	Gommelshausen, Wurt.		
939	"	"	Cornbrash No. 39	1	Vœgesheim, Baden		
940	"	"	Oolitic Limestone No. 40	1	Kandern, Baden		
941	"	"	Clay Ironstone No. 41	1	Wurtemberg		
942	"	"	Lias Slate No. 42	1	Boli, Wurt.	Lias	
943	"	"	Lias Marl No. 43	1	Kulmbach, Bavaria	"	
944	"	"	Lias Limestone No. 44	1	Malsch, Baden	"	
945	"	"	Lias Sandstone No. 45	1	Wurtemburg	"	
946	"	"	Slate No. 46	1	St. Cassian, Tyrol		
947	"	"	Limestone No. 47	1	Aussee, Styria		
948	"	"	Upper Keuper Sandstone No. 48	1	Degernloch, Wurtem		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
949	Nov. 1876	Geo. F. Kunz	Middle Keuper Sandstone No. 49	1	Heilbronn, Wurt		
950	"	"	Keuper Marl No. 50	1	Malsch, Baden		
951	"	Geol. Sur	Sandstone No. 51	1	Sinsheim, Baden		
952	"	"	Slate No. 52	1	Sinsheim, Baden		
953	"	"	"Muschelkalk" No. 53	1	Wiesloch, Baden		
954	"	"	Lower "Muschelkalk" No. 54	1	Mostroh		
955	"	"	"Bunter" Sandstone No. 55	1	Heidelberg		
956	"	"	Sandstone No. 56	1	Kaiserslautern		
954	"	"	Permian Gypsum No. 57	1	Ihlfeld, Harz	Permian	
958	"	"	"Nechstein" No. 58	1	Ilmenau, Thuringia		
959	"	"	Permian Dolomite No. 59	1	Eisleben, Thuringia	Permian	
960	"	"	Copper Slate No. 60	1	Rieschelsdorf, Hessia		
961	"	"	Permian "(Todtliegendes") No. 61	1	Baden	Permian	
962	"	"	Coal Slate No. 62	1	Saarbrucken	Carb.	
963	"	"	Cannel Coal No. 63	1	Wigan, Lancashire	"	
964	"	"	Carboniferous Sandstone No. 64	1	Zwickau, Saxony	"	
965	"	"	Carboniferous Sandstone No. 65	1	Le Fay, France	"	
966	"	"	Carboniferous Limestone No. 66	1	Tournay, France	"	
967	"	"	Devonian Limestone No. 67	1	Oberscheld, Nassau	Devonian	
968	"	"	Devonian Limestone No. 68	1	Hof, Bavaria	"	
969	"	"	Gray Wacke No. 69	1	Ober Lahnstein		
970	"	"	Clay Slate No. 70	1	Kaub on the Rhine		
971	"	"	Silurian Limestone No. 71	1	Prague, Bohemia	Silurian	
972	"	"	Silurian Limestone No. 72	1	Prague, Bohemia	"	
973	"	"	Slate No. 73	1	Hof, Bavaria		
974	"	"	Gneiss No. 74	1	Freiberg, Saxony		
975	"	"	Mica Slate No. 75	1	Gadernheim, Hessia		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
976	Nov. 1876	Geo. F. Kunz	Talcose Slate No. 76	7	Kolmbach		
977	"	"	Granular Limestone No. 77	1	Auerbach		
978	"	"	Granite No. 78	1	Schlierbach		
979	"	"	Graphic Granite No. 79	1	Zwiesel, Bavaria		
980	"	"	Syenite No. 80	1	Reichenbach		
981	"	"	Hornblende Rock No. 81	1	Schriesheim, Baden		
982	"	"	Eclogite No. 82	1	Silberbach		
983	"	"	Diorite No. 83	1	Dillenberg, Nassau		
984	"	"	Aphanite No. 84	1	Sechshelder, Nassau		
985	"	"	Spilite No. 85	1	Limburg		
986	"	"	Serpentine No. 86	1	Kupferberg, Bavaria		
987	"	"	Gabbro No. 87	1	Wurlitz		
988	"	"	Porphyry No. 88	1	Ziegelhausen, Baden		
989	"	"	Melaphyre No. 89	1	Ilmenau, Thuringia		
990	"	"	Basatt No. 90	1	Auerbach, Hessia		
991	"	"	Doleryte No. 91	1	Katzenbuckel		
992	"	"	Amygdaloidal Doleryte No. 92	1	Sasbach, Baden		
993	"	"	Phonolyte No. 93	1	Rhaengebirge		
994	"	"	Trachyte No. 94	1	Stenzelberg, Siebeng'b'g		
995	"	"	Sanidine Trachyte No. 95	1	Drachenfels		
996	"	"	Trachyte Conglomerate No. 96	1	Ober Dollendorf, Rhine.		
997	"	"	Trass No. 97	1	Brohl		
998	"	"	Pitchstone No. 98	1	Meissen, Saxony		
999	"	"	Obsidian No. 99	1	Lipari Isles		
1000	"	"	Lava No. 100	1	Mt. Vesuvius, Italy		
1001	"	"	Calamine	178	Ogdensburg, N. Y.		
1002	"	"	Calamine and Smithsonite	3	"		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1003	Nov. 1876	Geo. F. Kunz	Calamine	1	Franklin, N. J		
1004	"	"	Natrolite	96	Bergen Hill, N. J		
1005	"	"	Datolite	138	"		
1006	"	"	Calcite resembling Datolite	1	"		
1007	"	"	Calcite (modified)	5	"		
1008	"	"	Calcite	78	"		
1009	"	"	Calcite	11	Franklin, N. J		
1010	"	"	Mesolite	10	Bergen Hill, N. J		
1011	"	"	Datolite and compact Mesolite	2	"		
1012	"	"	Compact Mesolite	1	"		
1013	"	"	Mesolite and Datolite	1	"		
1014	"	"	Peculiar form of Calcite	1	"		
1015	"	"	Tabular Calcite	5	"		
1016	"	"	Natrolite, Analcite and Prehnite	1	"		
1017	"	"	Thomsonite	1	"		
1018	"	"	Smithonite	7	Franklin, N. J		
1019	"	"	Quartz	30	Hot Springs, Ark		
1020	"	"	Sussexite	1	Franklin, N. J		
1021	"	"	Seyberlite	1	Amity, N. Y		
1022	"	"	Datolite and Pyrite	2	Bergen Hill, N. J		
1023	"	"	Willemite (Troostite)	109	Franklin, N. J		
1024	"	"	Zincite (Ruby)	31	"		
1025	"	"	Amphibole (Hornblende)	135	"		
1026	"	"	Brown Tourmaline	1	"		
1027	"	"	Yellow Stilbite	1	Bergen Hill, N. J		
1028	"	"	Sphalerite (Compact Blende)	4	Bethlehem, Pa		Peculiar to locality
1929	"	"	Sphalerite (Blende)	36	Franklin, N. J		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1030	Nov. 1876	Geo. F. Kunz	Biotite (Black Iron Mica)	1	Franklin, N. J		
1031	"	"	Spartaite	5	"		
1032	"	"	Egyptian Marble	1	Italy		
1033	"	"	Chalcopyrite	1	Queensland		
1034	"	"	Cassiterite	1	New South Wales		
1035	"	"	Hydraulic Cement (Rock)	1	Rondout, N. Y		
1036	"	"	Franklinite	9	Franklin, N. J		
1037	"	"	Sphalerite (Compact Blende)	2	Bethlehem, Pa		Peculiar variety, only found here
1038	"	"	Compact Thomsonite	1	Bergen Hill, N. J		
1039	"	"	Willemite and Thomsonite	1	Franklin, N. J		
1040	"	"	Pectolite	175	Bergin Hill, N. J		
1041	"	"	Mountain Paper	1	West Chester Co., N. Y.		
1042	"	"	Brown Garnet	119	Franklin, N. J		
1043	"	"	Brown Garnet	1	"		The rest Wellemite (Troostite) and perhaps Pyroxene (Jeff.)
1044	"	"	Zincite	53	"		
1045	"	"	Quartz (Chert) in Schoharie grit	1	Schoharie, N. Y		
1046	"	"	Phlogopite	27	Franklin, N. J		Transparent through the sides
1047	"	"	Franklinite	273	"		
1048	"	"	Willemite	157	"		
1049	"	"	Franklinite and Zincite	180	"		
1050	"	"	Zincite (with Calcite)	49	"		
1051	"	"	Pyroxene	88	"		
1052	"	"	Chalcopyrite	4	"		
1053	"	"	Gahnite (Dysluite)	50	"		
1054	"	"	Graphite	100	New York		
1055	"	"	Tourmaline (Green)	34	Franklin, N. J		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1056	Nov. 1876	Geo. F. Kunz	Talc	12	Franklin, N. J		
1057	"	"	Serpentine (Precious Serpentine)	3	Montville, N. J		
1058	"	"	Calcite	3	Franklin, N. J		
1059	"	"	Apatite	18	"		
1060	"	"	Zincite and Willemite	3	"		
1061	"	"	Lepidomelane	9	"		
1062	"	"	Willemite, Franklinite and Zincite	8	"		
1063	"	"	Sussexite, Zincite and Franklinite	1	"		
1064	"	"	Franklinite, Zincite, Rhodochrosite (Dialogite) and Tephroite	1	"		
1065	"	"	Red and Green Corundum, Chondrodite	2	"		
1066	"	"	Garnet (Essomite)	1	"		
1067	"	"	Pyroxene and Amphibole (Pargasite)	2	"		
1068	"	"	Gahnite (Dysluite) and Garnet	3	"		
1069	"	"	Spinel	9	"		
1070	"	"	Chondrodite	8	"		
1071	"	"	Chondrodite and Fluorite	2	"		
1072	"	"	Epidote	5	"		
1073	"	"	Willemite (Troostite) and Franklinite	1	"		
1074	"	"	Pyroxene (Jeffersonite) and Apatite	1	"		
1075	"	"	Amphibole (Hornblende) and Titanite (Sphene)	30	"		
1076	"	"	Yellow Calcite	4	"		
1077	"	"	Black Garnet	35	"		
1078	"	"	Pyroxene (Jeffersonite)	44	"		
1079	"	"	Calcite (Stalactite)	1	Durham Cave, 10 mi. below Easton, Pa.		
1080	"	"	Native Copper	9	Lake Superior		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1081	Nov. 1876	Geo. F. Kunz	Garnet (Colophonite) and Franklinite	2	Franklin, N. J		
1082	"	"	Garnet, (Colophonite) Franklinite & Willemite.	1	"		
1083	"	"	Garnet, (Colophonite)	7	"		
1084	"	"	Pyroxene (Jeffersonite) and Garnet	3	"		
1085	"	"	Garnet, var. Melanite	75	"		
1086	"	"	Corundum (Sapphire)	1	"		
1087	"	"	Azurite	2	Chili		
1088	"	"	Iridescent Datolite	2	Bergen Hill, N. J		Very rare
1089	"	"	Prehnite	39	"		
1090	"	"	Feldspar	52	Turin, N. Y		
1091	"	"	Ruby Corundum	2	Franklin, N. J		
1092	"	"	Gold	2	North Carolina		
1093	"	"	Gold Quartz	3	California		
1094	"	"	Calcite	1	England		
1095	"	"	Pyromorphite (Brown Lead Ore)	1	Ems, Germany		
1096	"	"	Millerite	2	Gap Mimes, Pa		
1097	"	"	Pyrite	1	Roxbury, Ct		
1098	"	"	Surpentine (Chrysotile)	1	Montville, N. J		
1099	"	"	Talcose Slate	1	Staten Island		
1100	"	"	Rensselærite	3	St. Lawrence Co., N. Y.		
1101	"	"	Amphibole (Asbestus)	2	Baltimore, Md		
1102	"	"	Amphibole (Hornblende)	1	Amity, N. Y		
1103	"	"	Apophyllite and Laumontite	2	Bergen Hill, N. J		
1104	"	"	Fontainebleau Sandstone	1	Europe		Concretions
1105	"	"	Millerite, Hematite (Specular Iron) & Siderite	1	Antwerp, N. J		
1106	"	"	Calamine in Sphalerite (Blende)	2	Granby, Mo		
1107	"	"	Fibrous Red Hematite	1	Maryland		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality	Formation	Collector and Remarks.
	When.	Whence.					
1108	Nov. 1876	Geo. F. Kunz	Blue Corundum	1	Franklin, N. J		
1109	"	"	Staurolite	1	Georgia		
1110	"	"	Serpentine (Baltimorite)	1	Wood mine, Texas, Lancaster Co., Pa.		
1111	"	"	Anthophyllite	1	Wood mine. Texas, Lancaster Co., Pa.		
1112	"	"	Black Garnet	2	Franklin, N. J		
1113	"	"	Brown Garnet and Epidote	4			
1114	"	"	Aluminite (Hallite)	5	Texas, Pa		
1115	"	"	Grey Tephroite and Zincite	1	Franklin, N. J		
1116	"	"	Hematite (Specular Iron)	1	Island of Elba		
1117	"	"	Magnetite	2	Sussex Co., N. Y		
1118	"	"	Rutile (Rutilated Quartz)	1	Switzerland		
1119	"	"	Pinite (Agalmatolite)	1	China		
1120	"	"	Pent. Dodec Pyrite	11	New Jersey		
1121	"	"	Corundum	4	Franklin, N. J		
1122	"	"	Cuprite	1	Valparaizo, Chili		
1123	"	"	Prehnite and Natrolite	4	Bergen Hill, N. J		
1124	"	"	Silver aud Gold in Pyrite, Galenite (Galena)	1	California		
1125	"	"	Pyrite	40	Franklin, N. J		
1126	"	"	"Greenish Mica"	2	Connecticut		
1127	"	"	Millerite	3	Antwerp, N. Y		
1128	"	"	Phlogopite	6	St. Lawrence Co., N. Y.		
1129	"	"	Vesuvianite (Idocrase)	5	Amity, N. Y		
1130	"	"	Brookite	1	Ellenville, N. Y		Trauslucent yellow on quartz
1131	"	"	Stilbite	2	Poorah, Hindostan		
1132	"	"	Datolite and Natrolite	11	Bergen Hill, N. J		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1133	Nov. 1876	Geo. F. Kunz	Datolite and Stilbite	2	Bergen Hill, N.J		
1134	"	"	Apophyllite	67	"		
1135	"	"	Calcite and Stilbite	5	"		
1136	"	"	Quartz and Limonite,	1	Hoboken, N. J.		
1137	"	"	Stilbite	6	New York City		
1138	"	"	Calcite and Pyrite	11	Bergen Hill, N. J		
1139	"	"	Epidote	12	Franklin, N. J		
1140	"	"	Quartzite Conglomerate.,	1	Morristown, N. Y.		
1141	"	"	Crystalline Furnace Slag	1	Easton, Pa		
1142	"	"	Smithsonite	4	Franklin, N. J		
1143	"	"	Limonite and Gœthite (Lepidokrokite)	2	Chestnut Hill, Pa		
1144	"	"	Chabazite	1	New York City		
1145	"	"	Quartz	1	Dauphiney, France		
1146	"	"	Zincite and Tephroite	9	Franklin, N. J		
1147	"	"	Franklinite and Tephroite	9	"		
1148	"	"	Franklinite, Zincite and Tephroite	16	"		
1149	"	"	Franklinite, Zincite and Rhodonite	1	"		
1150	"	"	Calcite and Analcite	7	Bergen Hill, N.J		
1151	"	"	Witherite	6	England		
1152	"	"	Magnesite, compact	7	Hoboken, N. J.		
1153	"	"	Dolomite (Pearl Spar)	4	Lockport, N. Y	Niagara	
1154	"	"	Dolomite(Pearl Sp'r)and Calcite (DogTooth Sp'r	1	"		
1155	"	"	Serpentine	2	Gouverneur, N, Y.		
1156	"	"	Sussexite,Ruby Zincite and Rhodochrosite (Dia.	1	Franklin, N. J.		
1157	"	"	Herschelite and Gismondite in Trachyte	1	Cyclopean Islands		
1158	"	"	Slickensides	3	Franklin, N. J		
1159	"	"	Pectolite and Prehnite	3	Bergen Hill, N.J		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1160	Nov. 1870	Geo, F. Kunz	Stilbite	17	Bergen Hill, N.J		
1161	"	"	Sphalerite (Blende)	4	Missouri		
1162	"	"	Calcite (Dog Tooth Spar)	3	Lockport, N. Y		
1163	"	"	Spinel and Chondrodite	3	Franklin, N. J		
1164	"	"	Ophiolyte	1	New York City		
1165	"	"	Datolite and Calcite	3	Bergen Hill, N.J		
1166	"	"	Prehnite and Sphalerite (Blende)	1	"		
1167	"	"	Prehnite, Gmelinite and Blende	5	"		
1168	"	"	Ægirite	14	Near Magnet Cove, Ark		
1169	"	"	Chrysocolla	1	Maryland		
1170	"	"	Chrysocolla and Atacamite	1	"		
1171	"	"	Wulfenite and Pyromorphite	3	Southampton, Mass		
1172	"	"	Limonite	10	Staten Island		
1173	"	"	Quartz (Silicified Wood)	1	Colorado		
1174	"	"	Feldspar and Ægirite	1	Near Magnet Cove, Ark		
1175	"	"	Trap Crystals	2	Bergen Hill, N.J		
1176	"	"	Chalcopyrite	8	Tennessee		1
1177	"	"	Quartz (Moss-agate)	5	Cheyenne, W. T.		
1178	"	"	Copalite (Copal)	4	Zanzibar, Africa		
1179	"	"	Quartz (Smoky)	5	Colorado (Pikes Peak)		
1180	"	"	Quartz (Chalcedony)	2	Germany		
1181	"	"	Quartz (Agate)	2	"		With fine design
1182	"	"	Quartz (Jasper)	1	"		
1183	"	"	Quartz (Agate)	1			
1184	"	"	Quartz (Onyx)	1	Oberstein, Germany		
1185	"	"	Quartz (Agate)	1	Oberstein, Germany		
1186	"	"	Smoky Quartz	10	Magnet Cove, Ark		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1187	Nov. 1876	Geo. F. Kunz	Manganite	7	Nova Scotia		
1188	"	"	Sphalerite (Blende) and Pyrite	1	Pike's Peak, Col		Blende resembles Galena
1189	"	"	Magnetite	4	Nova Scotia		
1190	"	"	Beryl	1	Connecticut		
1191	"	"	Feldspar	1	New York City		
1192	"	"	Serpentine with Chromite	1	Hoboken, N. J		
1193	"	"	Magnetite	2	Port Henry		
1194	"	"	Siderite and Gneiss	1	New York City		
1195	"	"	Æginite on Orthoclase (Feldspar)	1	Near Magnet Cave, Ark.		
1196	"	"	Talc	1	Staten Island		
1197	"	"	Orthoclase	7	New York City		
1198	"	"	Apophyllite and Analcite	3	Bergen Hill, N. J		
1199	"	"	Apophyllite and Prehnite	2	"		
1200	"	"	Magnesite in Cerolite	6	Hoboken, N. J		
1201	"	"	Magnesite	1	"		
1202	"	"	Datolite. White	2	Bergen Hill, N. J		
1203	"	"	Analcite	12	"		
1204	"	"	Datolite and Natrolite	2	"		
1205	"	"	Natrolite and Analcite	2	"		Large cryst. for loc.
1206	"	"	Apophylite and Gmelinite	1	"		
1207	"	"	Datolite and Gmelinite	3	"		
1208	"	"	Natrolite and Apophyllite	2	"		
1209	"	"	Orthoclase (Adularia)	1	Windsor, Mass		
1210	"	"	Brown Harmotome	1	Hudson, N. Y		
1211	"	"	Shell Limestone	1	"		
1212	"	"	Graphite (Picture Mica)	1	Lancaster Co., Pa		
1213	"	"	Pyrrhotite	4	St. Anthony's Nose, N.Y.		

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimen.	Locality.	Formation	Collector and Remarks.
1214	Nov. 1876	Goe. F. Kunz	Chalcopyrite	7	Vermont		
1215	“	“	Chalcopyrite	2	Cuba		
1216	“	“	Pectolite	4	Bergen Hill, N. J		Odd form
1217	“	“	Calcite	1	Unknown		
1218	“	“	Slag	4	From Furnace near Easton, Pa		
1219	“	“	“From Iron Furnace”	1	Northern New York		
1220	“	“	Mica	4	Franklin, N. J		
1221	“	“	Natrolite and Stilbite	2	Bergen Hill, N. J		
1222	“	“	Thomsonite	5	“		
1223	“	“	Quartz	1	Hoboken, N. J		
1224	“	“	Garnet (Melanite)	1	Franklin, N. J		
1225	“	“	Opal	2	Honduras		
1226	“	“	Rhodonite (Crystals of Fowlerite)	1	Franklin, N. J		
1227	“	“	Pyrolusite	1	Germany		
1228	“	“	Pumice	2	“		
1229	“	“	Pyrite	6	Kentucky		
1230	“	“	Datolite and Analcite	2	Bergen Hill, N. J		
1231	“	“	Datolite, Natrolite and Prehnite	1	“		
1232	“	“	Barite	13	Cheshire, Ct		
1233	“	“	Calamine	1	Franklin, N. J		
1234	“	“	Aurichalcite (Green Calamine)	2	Ogdensburg, N. Y		
1235	“	“	Willemite (Troostite) and Franklinite	2	Franklin, N. J		
1236	“	“	Serpentine	6	Hoboken, N. J		
1237	“	“	Hematite (Specular Iron) after Franklinite	1	Franklin, N. J		
1238	“	“	Brucite	2	Hoboken, N. J		
1239	“	“	Hydromagnesite	5	“		

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Seiral Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1240	Nov. 1876	Geo. F. Kunz	Ægirite with Nephelite, (Elæolite)	6	Magnet Cave, Ark		
1241	"	"	Rutile (Nigrine)	38	"		
1242	"	"	Phosphatic Nodule	5	Charleston, S. C.		
1243	"	"	Wulfenite and Pyromorphite	5	Southampton, Mass		
1244	"	"	Quartz (Itacolumite)	7	North Carolina		
1245	"	"	Dolomite	3	Westchester Co., N. Y.		
1246	"	"	Chromite	1	Texas, Pa		
1247	"	"	Tourmaline	1	Delaware Co., Pa		Detached
1248	"	"	Columbite	4	New Alstead, N. H		
1249	"	"	Sussexite and Tephroite	1	Franklin, N. J		
1250	"	"	Cerussite and Pyromorphite	1	Phœnixville, Pa		
1251	"	"	Franklinite and Willemite	10	Franklin, N. J		
1252	"	"	Greenockite on Sphalerite (Blende)	2	Granby, Mo		
1253	"	"	Barite and Pyrite	1	Scales Mound, Ill		
1254	"	"	Brown Tourmaline	30	New York City		
1255	"	"	Psilomelane and Pyrolusite	2	Northern New York		
1256	"	"	Stibnite, Artificial	2	Hungary		
1257	"	"	Corundum	1	North Carolina		
1258	"	"	Aragonite	1	Unknown		
1259	"	"	Chabazite (Acadialite)	1	Nova Scotia		
1260	"	"	Dufrenite	2	Monmouth Co., N. J		
1261	"	"	Mineral Coal (Lignite)	5	England		
1262	"	"	Fossiliferous Hematite	1	Clinton, N. Y		
1263	"	"	Magnetite	1	Unkown		
1264	"	"	Radiated Gypsum	1	Nova Scotia		
1265	"	"	Barite	2	Scales Mound, Ill		
1266	"	"	Penninite (Kammererite)	3	Lancaster Co., Pa		

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1267	Nov. 1876	Geo. F. Kunz	Brookite (Arkansite) on Quartz	7	Magnet Cave, Ark		
1268	"	"	Brookite on Quartz	4	"		
1269	"	"	Willemite (Williamsite)	1	Texas, Pa		
1270	"	"	Fluorite	8	Franklin, N. J		
1271	"	"	Apatite	1	Rossie, N. Y		
1272	"	"	Smithsonite	2	Bethlehem, Pa		
1273	"	"	Ripidolite (Clinochlore)	1	Texas, Pa		
1274	"	"	Sphalerite (Cleiophane)	4	Franklin, N. J		
1275	"	"	Limonite (Bog Iron)	1	New York		
1276	"	"	Deweylite	1	Texas, Pa		
1277	"	"	Red Hematite	4	Nova Scotia		
1278	"	"	Amphibole (Hornblende) and Fluorite (Fluor)	1	Franklin, N. J		
1279	"	"	Amphibole (Hornblende) and Apatite	1	"		
1280	"	"	Talcose Slate	1	Staten Island		
1281	"	"	Gypsum	1	Cape Breton, N. Scotia		
1282	"	"	Sphalerite (Blende) and Greenockite	1	Granby, Mo		
1283	"	"	Calcite, Epidote and Copper	1	Lake Superior		
1284	"	"	Greenockite and Asphaltum (Bitumen) on Pyrargyrite (Ruby-Blende)	1	Oronogo, Mo		
1285	"	"	Sphalerite (Ruby Zinc-Blende)	4	"		
1286	"	"	Gypsum (Selenite)	3	Nova Scotia		
1287	"	"	Smithsonite on Calamine	1	Granby, Mo		
1288	"	"	Siderite	1	New Yoik City		
1289	"	"	Galenite (Galena)	2	Missouri		Peculiar Crystals
1290	"	"	Galenite, (Galena) Feathery	1	"		
1291	"	"	Wulfenite	6	Southampton, Mass		
1292	"	"	Regalar	3	Turkey		

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Serial Number.	Obtained.		Name.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
							27
1293	Nov. 1876	Geo. F. Kunz	Cyanite	1	Pennsylvania		
1294	"	"	Stilbite (Sphærostilbite)	2	Bergen Hill, N.J		Very rare
1295	"	"	Titanite (Sphene var Lederite)	1	Franklin. N. J		
1296	"	"	Wernerite (Scapolite)	16	Franklin, N. J		
1297	"	"	Tourmaline	1	Lambertville, Pa		
1298	"	"	Psilomelane	2	Hot Springs, Ark		
1299	"	"	"Pipe Ore"	2	Kentucky		
1300	"	"	Melaconite (Tenorite) and Calcite	1	Unknown		
1301	"	"	Zincite (Crystals of yellow Oxyde of Zinc)	1	Franklin, N. J		"From fused ore heaps."
1302	"	"	Psilomelane	2	Virginia		
1303	"	"	Molybdenite	1	Haddam, Conn		
1304	"	"	Ripidolite (Clinochlore)	4	Lancaster Co., Pa		
1305	"	"	Atacamite	2	Atacama, Chili		
1306	"	"	Prehnite, Thomsonite and Laumontite	1	Bergen Hill, N.J		
1307	"	"	Dioryte	1	"		
1308	"	"	Mineral Coal (Lignite)	1	Alaska		
1309	"	"	Azurite	1	Chili, S. A		
1310	"	"	Spodumene	1	Franklin, N. J		
1311	"	"	Amphibole (Tremolite)	1	Lewis Co., N. Y		
1312	"	"	Chalcocite	2	Bristol, Conn		
1313	"	"	Hypersthene	3	Lewis Co., N. Y		
1314	"	"	Ferruginous Quartz	5	Brooklyn, N. Y	Drift	
1315	"	"	Siderite	1	Easton, Pa		
1316	"	"	Talc (Steatite Pseudo after Pyroxene)	4	Franklin, N. J		
1317	"	"	Cacoxenite	1	Antwerp, N. Y		
1318	"	"	Zaratite	4	Texas, Pa		
1319	"	"	Amphibole (Hornblende) and Graphite	1	Amity, N. Y		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1320	Nov. 1876	Geo. F. Kunz	Uraconite (Uranochre)	1	St. Just, Scotland		
1321	"	"	Anglesite	1	Phœnixville, Pa		
1322	"	"	Hypersthene and Pyrite	1	Franklin, N. J		
1323	"	"	Amphibole (Hornblende) and Apatite	1	"		
1324	"	"	"Silver Mica"	1	"		
1325	"	"	Schorlomite	9	Magnet Cove, Ark		
1326	"	"	Garnet	1	Franklin, N. J		
1327	"	"	Quartz	10	"		
1328	"	"	Tourmaline	8	"		
1329	"	"	Hypersthene	1	"		
1330	"	"	Seybertite	2	"		
1331	"	"	Talc (Steatite, Pseudo, after some mineral)	1	"		
1332	"	"	Slickensides on White Topaz	1	"		
1333	"	"	Talc (Steatite on Graphite)	1	"		
1334	"	"	Phlogopite	2	Sterling, N. Y		
1335	"	"	Tourmaline	2	New York City		
1336	"	"	Garnet (Melanite) containing Schorlomite	4	Magnet Cove, Ark		
1337	"	"	Rhodochrosite (Dialogite)	2	Franklin, N. J		
1338	"	"	Willemite (Green—rare color)	11	"		
1339	"	"	Dolomite (Perl Spar) in trans Gypsum (Silenite)	1	Lockport, N. Y		
1340	"	"	Zincite and Dialogite	1	Franklin, N. J		
1341	"	"	Niceoliferous Pyrites	15	"		
1342	"	"	Franklinite and Lepidomelane (Black Mica)	1	"		
1343	"	"	Chalcopyrite	1	California		
1344	"	"	Sphalerite (Blende)	117	Oronogo, Mo		
1345	"	"	Hematite	1	Antwerp, N. Y		
1346	"	"	Quartz (Chalcedony)	1	Mt. Tom, Mass		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1347	Nov. 1876	Geo. F. Kunz	Quartz (Flint), with fossils from chalk	1	England		
1348	"	"	"Lithomarge."	1	Bergen Hill, N. J		
1349	"	"	Prehnite and Thomsonite	1	"		
1350	"	"	Orthoclase	1	Dixon's Quarry, Del		
1351	"	"	Malachite in Red Hematite	1	Maryland		
1352	"	"	Stilbite	4	Franklin, N. J		
1353	"	"	Brown Tourmaline	2	"		
1354	"	"	Red Hematite	1	Staten Island		
1355	"	"	Mineral Coal (Cannel Coal)	2	England		
1356	"	"	Mineral Coal (Anthracite)	1	Scranton, Pa		
1357	"	"	Quartz	9	Ellenville, N. Y.		
1358	"	"	Quartz	1	Switzerland		
1359	"	"	Fluorite	1	Muscalonge Lake, N. Y.		
1360	"	"	Garnet (Essonite)	1	New Hampshire		
1361	"	"	Pyroxene and Amphibole (Hornblende)	2	Franklin, N. J		
1362	"	"	Sphalerite (Blende) and Asphaltum (Bit'n)	1	Missouri		
1363	"	"	Amphibole (Hornblende) and Graphite	1	Franklin, N. J		
1364	"	"	Spinel	1	Hamburg, N. Y		
1365	"	"	Gypsum (Selenite)	1	Nova Scotia		
1366	"	"	Malachite	1			
1367	"	"	Chromite	1	California		
1368	"	"	Serpentine	1	Hoboken, N. J		
1369	"	"	Epidote	2	Lake Superior		
1370	"	"	Epidote and Orthoclase	3	"		
1371	"	"	Epidote and Quartz	1	"		
1372	"	"	Green and Red Corundum	1	Franklin, N, J		
1373	"	"	Sphalerite (Blende) and Galenite (Galena)	3	Oronogo, Mo		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1374	Nov. 1876	Geo. F. Kunz	Copper in Calcite with Epidote	2	Lake Superior		
1375	"	"	"Spiegeleisen"	1	Sweden		
1376	"	"	Magnetite	1	Franklin, N. J		
1377	"	"	Amygdaloid	1	Massachusetts		
1378	"	"	Galenite in Fluorite	2	Galena, Ill		
1379	"	"	Pyrargyrite (Ruby Blende)	3	Oronogo, Mo		
1380	"	"	Siderite (Carbonate of Iron)	1	North Carolina		
1381	"	"	Psilomelane	2	Northern New York		
1382	"	"	Chromite and Penninite	2	Texas, Pa		
1383	"	"	Calamine and Sphalerite (Blende)	1	Missouri		
1384	"	"	Calcite and Dolomite (Pearl Spar)	1	Lockport, N. Y		
1385	"	"	Quartz (Chalcedony) on Trihedral Quartz	1	Poorah, Hindostan		
1386	"	"	Galenite and Pyrargyrite (Ruby Blende)	2	Oronogo, Mo		
1387	"	"	White and Red Zincite	2	Franklin, N. J		
1388	"	"	Calamine	2	Granby, Mo		
1389	"	"	Epidote and Orthoclase (Feldspar)	9	Lake Superior		
1390	"	"	Galenite	6	Oronogo, Mo		
1391	"	"	Franklinite and Ruby Zincite	2	Franklin, N. J		
1392	"	"	Ferruginous Quartz	1	Connecticut		
1393	"	"	Pinite (Agalmatolite)	1	China		Chinese figure stone
1394	"	"	Apatite	4	Bob Lake, Canada		
1395	"	"	"Kidney Ore,"	1	Bethlehem. Pa		
1396	"	"	Red Hematite	1	Antwerp, N. Y		
1397	"	"	Limonite	3	Salisbury, Conn		
1398	"	"	Diaspore	2	Chester, Mass		
1399	"	"	Slag from Furnace	1	New York		
1400	"	"	Cuprite	1	England		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formotion	Collector and Remarks.
1401	Nov. 1876	Geo. F. Kunz	Pyrite. Pent. Dodec	1	Belgium		
1402	"	"	Sulphur	1	Sabine, West Indies		
1403	"	"	Native Bismuth	1	Connecticut		
1404	"	"	Pyrophyllite	1	Deep River, N. C.		
1405	"	"	Collyrite (Dillnite) with Diaspore	1	Shemnitz, Hungary		
1406	"	"	Feldspar	1	Desert of Sinai, Africa		
1407	"	"	Garnet	1	Piedmont, Italy		
1408	"	"	Garnet	2	New Town, Conn		
1409	"	"	Garnet	1	Canada		
1410	"	"	Garnet	1	St. Lawrence Co., N. Y.		
1411	"	"	Quartz (Chalcedony)	1	Poonah, Hindostan		
1412	"	"	Beauxite	1	Cabasse. France		
1413	"	"	Feldspar	2	Lewis County, N. Y.		
1414	"	"	"Red Ochre"	1	Staten Island		
1415	"	"	Beryl	2	Ackworth, N. H.		
1416	"	"	Heulandite	1	New York City		
1417	"	"	Serpentine (Marmolite)	1	Hoboken, N. Y.		
1418	"	"	Calamine	1	Saucon Valley, Pa		
1419	"	"	Quartz (Chalcedony)	1	Florida		
1420	"	"	Pyrite in Coal Shale	1	Scanton, Pa		
1421	"	"	Hauynite (in Lava)	1	Anderbach, Ger.		
1422	"	"	Native Copper with Silver	1	Lake Superior		Showing Silver in spots
1423	"	"	Magnetite	2	Nova Scotia		
1424	"	"	Quartz (Petrified Wood)	1	California		
1425	"	"	White Apatite	1	Santander, Spain		
1426	"	"	Amphibole (Tremolite)	3	Gouverneur, N. Y.		
1427	"	"	Glauberite and Mexite, (Hayesine)	2	Iquique, S. A.		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1428	Nov. 1876	Geo. F. Kunz	Aragonite	1	Bastennes Landes, Fr.		
1429	"	"	Quartz (Brown Jasper)	2	Murphreys, Cal		
1430	"	"	Orthoclase	1	Liperville, Pa		
1431	"	"	Quartz (Silicified Wood)	1	Nevada County, Cal		
1432	"	"	Cerolite	1	Hoboken, N. J		
1433	"	"	Molybnite	1	Westmoreland. Mass		
1434	"	"	Cyanite	2	Trumbull. Conn		
1435	"	"	Serpentine	1	St. Lawrence, N. Y		
1436	"	"	Serpentine (Precious Serpentine)	1	Gouverneur, N. Y		
1437	"	"	Hematite (Specular Iron)	3	Antwerp, N. Y		
1438	"	"	Sphalerite (Blende)	1	Ellenville, N. Y		
1439	"	"	Quartz containing Asphaltum (Bitumen)	4	Herkimer County, N. Y.		
1440	"	"	"Hagemanite"	1	Ivigtut, Greenland		
1441	"	"	Cinnabar	1	West California		
1442	"	"	Cerussite	1	Germany		
1443	"	"	Cerussite	2	Davidson County, N. C.		
1444	"	"	Chrysolite (Olivine) in Trap	1	Europe		Exact locality unknown
1445	"	"	Quartz (Calloused)	128	Crystal Mountains, Ark.		
1446	"	"	Quartz	3	Unknown		
1447	"	"	Quartz from Lead Mine	1	Southampton, Mass		
1448	"	"	Calcite [modified]	1	Bergen Hill. N. J		
1449	"	"	Quartz (Geode)	1	Illinois		
1450	"	"	Tourmaline and Smoky Quartz	1	New York City		
1451	"	"	Brucite	1	Texas, Pa		
1452	"	"	Mica Crystals	1	Sterling, N. J		
1453	"	"	Calcite	1	Roseville, N. J		
1454	"	"	Flourite and Apatite	1	Franklin, N. J		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1455	Nov. 1876	Geo. F. Kunz.	Amphibole (Byssotite)	1	Bergen Hill, N. J		
1456	"	"	Calcite (Calc Tufa)	1	Cansted, Germany		
1457	"	"	Porcelanite (Porcelain Jasperi	1	Germany		
1458	"	"	Gmelinite	1	Two Islands, N. Scotia		
1459	"	"	Quartz (Jasper) and Serpentine	1	Hoboken, N. J		Point of contact between—
1460	"	"	Graphite Picture Mica	5	Sussex Co., N. J		
1461	"	"	Quartz (Rose)	1	Franklin, N. J		
1462	"	"	Apophyllite	6	Bergen Hill, N. J		Crystals of a rare form
1463	"	"	Mica	2	New Hampshire		
1464	"	"	Titanite (Sphene)	4	Franklin, N. J		
1465	"	"	Titanite (Sphene)	1	Diana, N. Y		
1466	"	"	Mica	2	New York City		
1467	"	"	Quartz (Green Jasper)	1	Connecticut		
1468	"	"	Feldspar	1	France		[form
1469	"	"	Prehnite and Pectolite (crystallized)	1	Bergen Hill, N. J		In separate crystals—very rare
1470	"	"	Geode of Limonite	1	Staten Island, N. Y		
1471	"	"	Pyrites (radiated)	1	Germany		
1472	"	"	Iridescent Limonite	1	Chestnut Hill, Pa		
1473	"	"	Quartz (Amethyst)	2	Thunder Bay, L. S.		
1474	"	"	Quartz	1	Parana, Brazil		
1475	"	"	Quartz (in matrix)	1	Herkimer Co., N. Y		In calciferous sandrock
1476	"	"	Analcite	1	Cyclopean Is		Rare form—clear and showing
1477	"	"	Rhodonite (Fowlerite crystallized)	1	Franklin, N. J		[face of cube
1478	"	"	Rhodocrosite (Dialogite)	1	Franklin, N. J		Contains Magnesia
1479	"	"	Pyroxene (Pargasite)	2	Franklin, N. J		
1480	"	"	Calcite (Argentine)	4	Montville, N. J		
1481	"	"	Quartz (Bloodstone)	4	Texas		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality	Formation	Collector and Remarks.
1482	Nov. 1876	Geo. F. Kunz	Quartz (Rose)	2	Haddam, Ct.		
1483	"	"	Rutile	1	Franklin, N. J.		
1484	"	"	Serpentine (Chrysotile)	3	Montville, N. J.		
1485	"	"	Compact Garnet	1	New York City		
1486	"	"	Pyroxene	1	Lewis Co. N. Y.		
1487	"	"	Cyanite (Rhætizite)	1	Germany		
1488	"	"	Pectolite	2	Bergen Hill, N. J.		Rare forms
1489	"	"	Stilbite	1	Nova Scotia		
1490	"	"	Quartz	2	Herkimer Co. N. Y.		Showing empty cavities
1491	"	"	Muscovite	2	St. Lawrence, N. Y.		
1492	"	"	Calcite	4	Rossie, N. Y.		
1493	"	"	Serpentine	3	Montville, N. J.		
1494	"	"	Apophyllite containing Ripidolite (Chlorite)	1	Bergen Hill, N. J.		
1495	"	"	Copalite (with insects)	2	Zanzibar, Africa		
1496	"	"	Pyrite (auriferous)	1	Queensland		With Chalcopyrite
1497	"	"	Antimony (from Stibnite)	1	Victoria		
1498	"	"	Corundum (Sapphire)	1	Vernon, N. J.		
1499	"	"	Mesolite and Calcite	4	Bergen Hill		
1500	"	"	Gmelinite on Datolite	2	Bergen Hill		White and rare
1501	"	"	Apophllyte and Stilbite	1	Bergen Hill, N. J.		
1502	"	"	Calcite (Dog Tooth Spar)	5	Missouri		
1503	"	"	"Satin Spar"	2	Wales		
1504	"	"	Naumannite on Garnet	4	Victoria, Australia		
1505	"	"	Pyroxene	1	Lewis Co, N. Y.		
1506	"	"	Calcite (Spartaite)	1	Sparta, N. J.		
1507	"	"	Red and Green Tourmaline	2	Minas Geras, Brazil		
1508	"	"	Wollastonite	1	Near Haverstraw, N. Y.		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		Name.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1509	Nov. 1876	Geo. F. Kunz	Thomsenolite	1	Tvigtut, Greenland		
1510	"	"	Smithsonite	1	Zinc Co., Mo		
1511	"	"	Pyrite and Galenite	1	Rossie, N. Y		
1512	"	"	Spinel and Corundum [gite.	1	Franklin, N. J		
1513	"	"	Franklinite, Zincite and Rhodochrosite (Dialo-	1	Franklin, N. J		
1514	"	"	"Scapolite" on Amphibole (Hornblende)	1	Franklin, N. J		
1515	"	"	Stilbite	2	Southbury, Connecticut		
1516	"	"	Green Tourmaline	2	Franklin, N. J		
1517	"	"	Manganite	1	Franklin, N. J		
1518	"	"	Wernerite	2	Lewis Co., N. Y		
1519	"	"	Vivianite (Mullicite)	1	Mullica Hill, N. J		
1520	"	"	Analcite (Analcime)	1	Nova Scotia		
1521	"	"	Seybertite (Clintonite)	3	Franklin, N. J		
1522	"	"	Scapolite and Phlogopite	1	Franklin, N. J		
1523	"	"	Barite	1	England		
1524	"	"	Schorlomite and Garnet	1	Magnet Cove, Ark		
1525	"	"	Halloysite (Indianaite)	1	Indiana		
1526	"	"	Unknown	1	Bergen Hill, N. J		
1527	"	"	Pyrite	1	Roxbury, Ct		
1528	"	"	Bornite and Chalcopyrite	1	Bristol, Ct		
1529	"	"	Gold Quartz	1	Victoria, Australia		
1530	"	"	Hematite (Specular Iron.)	1	Germany		
1531	"	"	"Sussexite," (Rare)	23	Franklin, N. J		
1532	"	"	Lepidolite	1	Hebron, Maine		
1533	"	"	Phillipsite in Trachyte	1	Italy		
1534	"	"	Chalcostibite (Antimonial Copper)	1	Chili		
1535	"	"	Garnet (Colophonite)	1	Franklin, N. J		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formotion	Collector and Remarks.
1536	Nov. 1876	Geo. F. Kunz	Willemite (Troostite) and Calcite (Spartaite)	1	Franklin, N. J.		
1537	"	"	Willemite and Calcite (Spartaite)	2	"		
1538	"	"	Franklinite and Calcite (Spartaite)	8	"		
1539	"	"	Franklinite and Rhodochrosite [Dialogite]	1	"		
1540	"	"	Soda Nitre [Nitratine]	3	Plainsof TerrapaccaS.A		
1541	"	"	Datolite [Massive]	1	Bergen Hill, N. J.		
1542	"	"	Galeuite	1	Spain		
1543	"	"	Galenite	2	Illinois		
1544	"	"	Tourmaline	2	Franklin, N. J.		
1545	"	"	Prehnite and Copper	1	Lake Superior		
1546	"	"	"Tvigtite"	1	Tvigtut, Greenland		
1547	"	"	Quartz [Amethyst]	3	Lancaster Co., Pa.		
1548	"	"	Apophyllite and Pectolite [primitive]	1	Bergen Hill, N. J.		
1549	"	"	Vanadinite [Crystallized]	1	Corinthia, Europe		
1550	"	"	Datolite and Yellow Stilbite	1	Bergen Hill, N. J.		
1551	"	"	Pyrite	1			
1552	"	"	Orthoclase	12	Colorado		
1553	"	"	Garnet	5	New Towu Ct.		
1554	"	"	Brookite	12	Magnet Cove, Ark.		
1555	"	"	Staurolite	3	New Hampshire		
1556	"	"	Aluminite [Hallite]	4	Notingham, Pa.		
1557	"	"	Chlorastrolite	40	Isle Royale, L. Superior		Rare in Rock
1558	"	"	Azurite	1	Chessy, France		
1559	"	"	Stibiconite [Partzite and Stetefeldtite]	1	Belmont, Nevada		
1560	"	"	Algodonite	1	Chili		
1561	"	"	Cassiterite [Stream Tin]	20	Durango, Mexico		
1562	"	"	Brookite [Arkansite] and Rutile ? [Nigrine]	Indf	Magnet Cove, Ark.		Small and numerous

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1563	Nov. 1876	Geo. F. Kunz	Brookite [Arkansite]	14	Magnet Cove, Ark		Small and numerous
1564	"	"	Topaz [rite.	10	Durango, Mexico		
1565	"	"	Titanite [Green Sphene] with Ripidolite [Chlo-	2	Tyrol		
1566	"	"	Rutile	9	Lynchburg, Va		
1567	"	"	Native Lead	1	Granada, Spain		
1568	"	"	Vivianite	5	Mullica Hill, N. J		
1569	"	"	Cassiterite [Stream Tin]	14	Durango, Mexico		
1570	"	"	Microlite	2	Chesterfield, Mass		
1571	"	"	Atacamite	1	Chili		
1572	"	"	Spinel [Ruby]	20	Franklin, N. J		
1573	"	"	"Stevensite"	5	Bergen Hill, N. J		
1574	"	"	Fibrous Malachite	1	Germany		
1575	"	"	Quartz	1			
1576	"	"	Mica and Spinel [Ruby]	1	Franklin, N. J		
1577	"	"	Amphibole [Hornblende]	1	Spain		
1578	"	"	Gismondite and Analcite	1	Cyclopean Islands		
1579	"	"	Laumontite and Datolite	2	Bergen Hill, N. J		
1580	"	"	Quartz [Carnelian]	1	Germany		
1581	"	"	Chrysocolla	6	Chili, S. A		
1582	"	"	Smoky Quartz	1	St. Gothard, Switzerl'nd		
1583	"	"	Chrysolite [Olivine]	3	Arizona		
1584	"	"	Quartz [Amethyst]	3	Brazil		
1585	"	"	Lapis-Lazuli	1	Siberia		
1586	"	"	"Black Mica"	2	New York City		
1587	"	"	Iridescent Franklinite and Willemite	1	Franklin, N. J		
1588	"	"	Opal	1	North Carolina		
1589	"	"	Ruby, Sapphire, &c	75	Franklin, N. J		Indefinite

Catalogue of Specimens Rigistered in the General Museum in 1877—Continued.

Serial Number.	Obtained.		Name.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1590	Nov. 1876	Geo. F. Kuntz	Epidote	1	Tyrol, Europe		
1591	"	"	Quartz crystal penetrated by another crystal	1	Herkimer Co., N. Y.		
1592	"	"	Talc [Steatite, Pseudo-after Staurolite]	1	Germany		
1593	"	"	Stromeyerite	1	Arizona		
1594	"	"	Quartz [Black Jasper]	1	Europe		
1595	"	"	Quartz [Sard or Carnelian]	1	Europe		
1596	"	"	Native silver	1	Mexico		
1597	"	"	Natrolite	1	Vesuvius, Italy		
1598	"	"	Green quartz containing ripidolite [Chlorite]	1	Olisville. N. Y.		
1599	"	"	Calcite	1	Lake Superior		
1600	"	"	Quartz containing Psilomelane	1	Hot Springs, Ark.		
1601	"	"	Opal	10	Hungary		
1602	"	"	Amphibole [Asbestus]	1	North Carolina... [Ark.		
1603	"	"	"Quartz Cappings."	3	40 m. from Hot Springs,		
1604	"	"	Columbite	10	Haddam, Ct.		
1605	"	"	Quartz	28	Herkimer, Co., N. Y.		
1606	"	"	Kalinite [Native Alum]	1	Mt. Morris, N. Y. city		
1607	"	"	Diamond	1	South Africa		
1608	"	"	Topaz [Colored]	Indf	Durango, Mexico		
1609	"	"	Topaz [doubly terminated]	1	" "		
1610	"	"	"Durangite."	Indf	" "		From stream—tin.
1611	"	"	Zircon	3	Franklin, N. J.		
1612	"	"	"Syngenite"	1	Poland, Galacia		Very rare.
1613	"	"	Iridosmine		Oregon		
1614	"	"	Menaccanite [Titanic iron sand containing gold garnet and zircon	Indf	"		
1615	"	"	Menaccanite [Iserina]	Indf	Switzerland		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1616	Nov. 1876	Geo. F. Kuntz	Dioptase	1	Gherghes Steppes, Si-		
1617	"	"	Quartz [Agate and Chlorastrolite]	Indf	Isle Royal, L. S...[ber'a		
1618	"	"	Mellite [Honey Stone]	2	Thuringia		
1619	"	"	Silver [wire]		Mexico		
1620	"	"	Beryl	1	Siberia		
1621	"	"	Apatite	1	Rosse, N. Y.		
1622	"	"	Nytive Tellurium	1	Transylvania		
1623	"	"	Apatite	2			
1624	"	"	Topaz	7	Brazil		
1625	"	"	Andalusite [Chiastolite] [angite."	1	Massachusetts		
1626	"	"	Cassitere [stream tin] with topazes and "Dur-	Indf	Durango, Mexico		
1627	"	"	Amphibole [Amianthus]		North Carolina		
1628	"	"	Native copper	1	Lake Superior		From a fissure
1629	"	"	Geode	1	Iowa		
1630	"	"	Quartz [Chalcedony after wood]	1	California		
1631	"	"	Quartz [Silicified wood]	1	Nevada Co. Nev.		
1632	"	"	Asphaltum [Albertite]	3	Nova Scotia		
1633	"	"	Kieserite		Stassfurt, Germany		
1634	"	"	Glauberite		Laramie Plaines, U. S.		
1635	"	"	Picromerite]Kainite]		Stassfurt, Germany		
1636	"	"	Sylvite		" "		
1637	"	"	Tachhydrite		" "		
1638	"	"	Polyhalite		" "		
1639	"	"	Carnallite		" "		[of University of Va.
1640	"	"	Meteoric iron		Virginia		Fall of 1868 from Prof. Mallet,
1641	"	"	Gold	1	Nova Scotia		
1642	"	"	Orthaclase [Amazon Stone]	1	Pike's Peak, Col		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1643	Nov. 1876	Geo. F. Kunz	Graphite	5	Ceylon		
1644	"	"	Kaolinite	5	England		
1645	"	"	Kaolinite	3	Delaware		
1646	"	"	Chrysoberyl	1	Greenfield, N. Y		
1647	"	"	Chalcopyrite and Seybertite (Clintonite)	1	Franklin, N. J		
1648	"	"	Gold	1	Australiia		
1649	"	"	"Silver ore"	1	White Pne, Col		
1650	"	"	Gypsum (Selenite)	1	Zanesville, Ohio		
1651	"	"	Scolecite	1	Poonah, India		
1652	"	"	Lava, with coin put in while hot	1	Vesuvius, Italy		
1653	"	"	Lazulite	6	Lincoln Co., Georgia		
1654	"	"	Limonite	2	Near Franklin, N. J		
1655	"	"	Quartz (Amethyst)	2	England		
1656	"	"	Amphibole [Asbestus]	5	Staten Isiand, N. Y		
1657	"	"	Mineral coal [Peacock coal]	4	Wilkesbarre, Pa		
1658	"	"	White Staurolite	1	Hanover, N. H.		
1659	"	"	Native Silver	1	Chili, S. A		
1660	"	"	Gold and Silver	1	Gould & Curry mine, Cal		
1661	"	"	Serpentine [Antigorite]	1	Antigoras, Piedmont		
1662	"	"	Quartz [Amethyst]	1	Hugnary		
1663	"	"	Molybdite	1	Strahope, N. J		
1664	"	"	Biotite	1	New York State		
1665	"	"	Calcite	1	Rossie, N. Y		
1666	"	"	Amphibole [Radiated Tremolite]	1	Barrington, Mass		
1667	"	"	Octahedrite [Anatase] and Quartz	1	St. Gothard, Switz		
1668	"	"	Lava	2	Vesuvius, Italy		
1669	"	"	Lava	1	Sandwich Islands		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1670	Nov. 1876	Geo. F. Kunz	Pyrite	1	Jeddo Coal Mines, Pa.		
1671	"	"	Pyrite	1	Rossie, N. Y		
1672	"	"	Rutile	2	Lincoln Co., Georgia		
1673			Rutile	1	Lancaster Co., Pa		
1674	"	"	Black Tourmaline	1	Rossie, N. Y		
1675			Tourmaline	1	Haddam, Ct		
1676	"	"	"Black Mica"	1	Franklin, N. J		
1677	"	"	"Mica, magnetited"	3	New York City		
1678	"	"	Quartz	1	Dubuque, Iowa		
1679	"	"	Pyrite Sphaeerite (dodecahedral Blende)	1	Pike's Peak, Col		
1680	"	"	Magnetite (native Magnet)	4	Magnet Cove, Ark		
1681	"	"	Chalcanthite (native Sulphate of Copper)		Cornwall, England		
1682	"	"	Gypsum	3	Mammoth Cave, Ky		
1683	"	"	Kaolinite (Argilliform)	2	Woodbridge, N. J		
1684	"	"	Odd Quartz	1	Magnet Cove, Ark		
1685	"	"	Doubly Terminated Milky Quartz	1	Magnet Cove, Ark		
1686	"	"	Quartz	1	Phœnixville, Pa		
1687	"	"	Calcite	1	Lake Superior		Rock on which Duluth is built
1688	"	"	"Satin Spar"	4	Nova Scotia		
1689	"	"	Quartz in Calc. Sand Rock	7	Herkimer Co., N. Y		
1690	"	"	Asphaltum (Bitumen, on Quartz calc. Sand R'k	1	Herkimer Co., N. Y		
1691	"	"	"Mica, magnetited"	1	New Hampshire		
1692	"	"	Galenite	1	Colorado		
1693	"	"	Sphalerite (Blende)	2	Phœnixville, Pa		
1694	"	"	Tourmaline	6	Chester, Mass		
1695	"	"	Celestite	1	Mt. Gergenti, Sicily		
1696	"	"	Quartz (Amethyst) and Fluorite	1	England		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		Name.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1697	Nov. 1876	Geo. F. Kunz	Halite	4	St. Martinsville, La		
1698	"	"	Halite	1	Utah Territory		
1699	"	"	Limonite after Pyrite	1	Pennsylvania		
1700	"	"	Sphalerite [Blende] and Galenite on Quartz	1			
1701	"	"	Gypsum [Selenite]	1	Cayuga Lake, N. Y.		
1702	"	"	Barite	1	Gibralter		
1703	"	"	Calcite]Calc Tufa]	1	Litchfield, N. Y.		
1704	"	"	Allanite	5	Franklin, N. J.		
1705	"	"	Jefferisite	4	Westchester, Ch'r Co. Pa		
1706	"	"	Muscovite	2	Jefferson Co. N. Y.		
1707	"	"	Jeffersite	2	Connecticut		
1708	"	"	Serpentine	1	Pennsylvania		
1709	"	"	Chalcocite [Sulphide of Copper] after Wood	1	New Mexico		
1710	"	"	Azurite and Malachite	1	"		
1711	"	"	Gypsum	1	Dubuque, Iowa		
1712	"	"	Amphibole [Tremolite] in Dolomite	2	Lee, Mass.		
1713	"	"	Garnet	1	Hanover, N. H.		1
1714	"	"	Strontianite	1	England		
1715	"	"	Magnesite [White, Compact]	1	Hoboken, N. J.		
1716	"	"	Malachite	3	Chili, S. A.		
1717	"	"	Gypsum [Alabaster]	1	Cape Breton, N. S.		
1718	"	"	Green Tourmaline	1	Paris, Maine		
1719	"	"	Limonite	1	Chestnut Hill, LanCo Pa		
1720	"	"	Calcite [" Rock Milk "]	1	Watertown, N. Y.		
1721	"	"	Gothite [Lepidocrocite]	1	Chestnut Hill, Pa.		
1722	"	"	Aragonite, " Mexican Onyx "	1	Mexico		
1723	"	"	Stilpnomelane [Chalcodite]	1	Sterling Mine Anw'p NY		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1724	Nov. 1876	Geo. F. Kunz	Ægirite (Black)	1	40 mile w Mag. Cove, Ark		
1725	"	"	Euxenite	1	Norway		
1726	"	"	Embolite	1	Silver City, Colorado		The "Bogus Silver Ore" from
1727	"	"	Pyrite in Gneiss	1	New York City		Western Boulevard and 105 st.
1728	"	"	Rhodonite (Fowlerite)	1	Franklin, N. J.		N. Y. City caused great excite
1729	"	"	Chabazite (White)	1	Ausig, Bohemia		ment
1730	"	"	Anorthite (Indianite)	2	Chester, Mass.		
1731	"	"	Limonite (Bog Iron Ore, after Wood)	1	New York State		
1732	"	"	Calcite (Fibrous Carb. of Lime)	2	Chicopee, Mass		
1733	"	"	Fluorite	1	Derbyshire England		
1734	"	"	Porphyry [dite	1	Spain		
1735	"	"	Cassiterite Fluorite and Lepidolite (Zinnwal-	1	Paris, Maine		
1736	"	"	Fetid Limestone	1	Massachusetts		
1737	"	"	Albite	2	New York City		
1738	"	"	Berthicrite	1	Hayunge, Depar't of the Mosselle, France		
1739	"	"	Malachite	1	New Mexico		
1740	"	"	Prehnite	1	Tyrol		
1741	"	"	Serpentine (Williamsite)	1	Pennsylvania		
1742	"	"	Calcite (Dog-Tooth Spar) [domelane	1	Bergen Hill, N. J.		
1743	"	"	Cancrinite with Torbernite (Chalcolite) Lepi-	3	Litchfield, Me.		
1744	"	"	Triphylite	1	Grafton, Vr.		
1745	"	"	Titanite (Sphene, Lederite)	1	New York		
1746	"	"	Titanite (Lederite)	2	Franklin, N. J,		
1747	"	"	Limonite coating Pyrite	1	Pennsylvania		
1748	"	"	Phlogopite	1	Canada		
1749	"	"	Samarskite	1	North Carolina		
1750	"	"	"Zonochlorite"	1	Hudson Bay Territory		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1751	Nov. 1876	Geo. F. Kunz	Celestite on Sulphur	3	Mt. Girgenti, Sicily		
1752	"	"	Cryolite, Sphalerite and Pyrite	1	Ivigtut, Greenland		
1753	"	"	Garnet	1	New York City		
1754	"	"	Covellite	1	Chili		
1855	"	"	Asphaltum	1	Egypt		[furnace.
1756	"	"	Fluorite [Fluate of lime]	2	Columbia, Pa		In Furnace Slag, St. Charles
1757	"	"	Amphibole [Tremolite]	1	Hartz, Germany		
1758	"	"	Brucite	2	Hoboken, N. J		Of rare occurrence at Hoboken
1759	"	"	Vanadinite	1	Lead Hills, Scotland		
1760	"	"	Pyrite	2	England		
1761	"	"	Gypsum, [Selenite, single crystal.]	1	Paris, France		
1762	"	"	Gypsum, [Selenite, twin crystals]	1	"		
1763	"	"	Vesicular lava with chrysolite	1	Sandwich Islands		
1764	"	"	"Carbonite."	1	Near Richmond. Va		
1765	"	"	Peganite	2	Near Hot Springs, Ark.		
1766	"	"	Genthite on Chromite	1	Wood's mine Lanc'r Co.		
1767	"	"	Blue Calcite [elane.	1	Lake Champlain...[Pa.		
1768	"	"	Cancrinite with Nephelite [Elæolite] Lepidom-	1	Litchfield, Me		
1769	"	"	Prehnite	1	Simsbuby, Conn.		
1770	"	"	Opal [Hyalite]	1	England		
1771	"	"	Calcite [Satin Spar]	1	Chicopee, Mass.		
1772	"	"	Limonite ["Pipe Ore."	2	Near Easton, Pa.		
1773	"	"	Hollowed Analcite	1	Bergen Hill, N. J..[Md.		
1774	"	"	Schistose Hematite	1	Bachman Val.Carrol Co.		
1775	"	"	Pyroxene [Augite] in Lava	1	Vesuvius, Italy		
1776	"	"	Margarodite	1	Chester, Mass.		
1777	"	"	"From a zinc furnace"	1	Virginia		Forty per cent. zinc

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1778	Nov. 1876	Geo. F. Knnz	Melaconite (Tenorite)	1	Chili		
1779	"	"	Siderite (Sphero siderite)	1	New York City		
1780	"	"	Samarskite	1	North Carolina		Crystal
1781	"	"	Mimetite (Campylite)	1	Dry gill, England		
1782	"	"	Hubnerite	1	California		
1783	"	"	Celestite	1	Magnet Cove, Ark		
1784	"	"	Tourmaline and oligoclase	2	Green Island, Lake Erie		
1785	"	"	Dolomite (Pearl spar) with Fluorite,	1	New York City		
1786	"	"	Grey Tephroite, Franklinite and zincite	1	Lockport, N. Y		
1787	"	"	Quartz (Chalcedony)	1	Franklin, N. J		
1788	"	"	"Jade"	1	Italy		
1789	"	"	Pyromorphite on quartz	1	Easton, Pa		
1790	"	"	Elaterite (Elastic Bitumen)	3	Phœnixville, Pa		
1791	"	"	Black Garnet containing schorlomite	1	Derbyshire, Eng		
1792	"	"	Radiated gypsum	1	Marseilles, France		
1793	"	"	Menaccanite in talc	1	Harford Co. Md		
1794	"	"	Quartz (Jasper)	1	Massachusetts		
1795	"	"	Talc	1	St. Lawrence Co., N. Y.		
1796	"	"	Serpentine and Calcite (Argentine)	1	Montville, N. J		
1797	"	"	Enargite	1	Alpine Co., Cal		[Plaster of Paris came.
1798	"	"	Gypsum	1	Paris, France		Quarry from which the name
1799	"	"	Hydrodolomite	1	Westchester Co., N. Y.		
1800	"	"	Th[illegible]enite	1	Lake Superior		
1801	"	"	Arsenic (native)	1	Germany		
1802	"	"	Vivianite	1	Monmouth Co., N. J		
1803	"	"	Wolframite (pseudo after Scheelite)	1	Connecticut		
1804	"	"	Calcite (Stalactite)	1	Dubuque, Iowa		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1805	Nov. 1876	Geo. F. Kunz	Quartz	2	Magnet Cove, Ark		
1806	"	"	Amphibole (Actinolite)	1	Holliston, Mass		
1807	"	"	Fluorite	1	Hardin Co., Ill		
1808	"	"	Sphalerite [Blende, showing cleavage]	1	Granby, Mo		
1809	"	"	Mineral Coal [Lignite Coal	1	Isthmus of Panama		
1810	"	"	Tourmaline [Indicolite] and Beryl [Goshenite]	1	Goshen, Mass		
1811	"	"	Witherite [radiated]	1	Newcastle, Eng		
1812	"	"	Chalcocite	1	Liberty Mine, Md		
1813	"	"	Dolomite [Pearl Spar]	1	Lancaster Co., Pa		
1814	"	"	Lesleyite	1	Newlin, Chester Co., Pa		
1815	"	"	Amphibole [Amianthus]	1	Harford Co., Md		
1816	"	"	Zircon	7	Buncome Co., N. C		
1817	"	"	Pinite [Gieseckite]	1	Nat.Br'dg,Lewis Co.N.Y		
1818	"	"	"Porcelain Jasper"	1	Germany		
1819	"	"	Brookite [Arkansite, in quartz]	1	Magnet Cove, Ark		
1820	"	"	Zincite [Oxide of Zinc]	2	Franklin, N. J		From fused ore heap
1821	"	"	Green Wavellite	2	Hot Springs, Ark		
1822	"	"	Pink Spinel in Pyroxene [Sahlite]	1	Vernon, N. J		
1823	"	"	Adamite	1	Toulon, France		
1824	"	"	Pyroxene	1	Northern, N. Y		
1825	"	"	Radiated Ripidolite	2	New York City		
1826	"	"	Aragonite	1	Mt. Girgenti, Sicily		
1827	"	"	Brucite	1	Wood'sMine.Lan co.Pa.		
1828	"	"	Azurite and Malachite	3	Franklin, N. J		
1829	"	"	Pyromorphite	3	Phœnixville, Pa		
1830	"	"	Magnetite (magnetic iron sand)		Long Island Beach		
1831	"	"	Magnetite	5	Near Stockholm, N. J		Ogden mine

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Seiral Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1832	Nov. 1876	Geo. F. Kunz	Magnetite	3	Near Bloomington, N. J		
1833	"	"	Magnetite	3	Roseville, N. Y		
1834	"	"	Magnetite	1	Byrain, N. J		
1835	"	"	Magnetite	1	New Jersey		
1836	"	"	Magnetite	2	Woodsport, N. J		
1837	"	"	Magnetite	12	Franklin, N. J		
1838	"	"	Stibnite	3	Hungary		
1839	"	"	Petrified wood	1	Middle Park, Col		
1840	"	"	Petrified wood	1	Colorado		
1841	"	"	Petrified wood	1	Colorado		
1842	"	"	Siderite (Carbonate of Iron)	1	New York City		
1843	"	"	Asphaltum	1	Bex, Switzerland		
1844	"	"	Mineral Coal (Lignite) with Pyrite	1	Ohio		
1845	"	"	Result of decomposition of Pyrite	1	Bergen Hill, N. J		
1846	"	"	Tourmaline (bent crystals)	1	Cecil Co., Md		
1847	"	"	Chromite	1	Wood's mine, Lan. co. Pa		
1848	"	"	Cryolite with Siderite	1	Arksut Bay, Greenland		
1849	"	"	Cyanite	2	Newton, Conn		
1850	"	"	Limonite	10	Hamburg, N. J		
1851	"	"	Pyrite	1	Bergen Hill, N. J		
1852	"	"	Galenite	1	Phœnixville, Pa		
1853	"	"	Magnetite	1	Dickinson Mine, N. J		
1854	"	"	Anthophyllite	1	Smithfield, R. I		
1855	"	"	Allanite (Orthite, crystals)	2	New York City		
1856	"	"	Ripidolite (Chlorite)	1	Franklin, N. J		
1857	"	"	Amphibole (Byssolite) and Ægirite	1	Hot Springs, Ark		
1858	"	"	Gothite (Feathery Lepidocrocite)	2	Chestnut Hill, Pa		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimen.	Locality.	Formation	Collector and Remarks.
1859	Nov. 1876	Goe. F. Kunz	Serpentine	1	Franklin, N. J		
1860	"	"	Stilbite resembing Wavellite	1	Philadelphia. Pa		
1861	"	"	Aragonite [ite) Crystals	1	Franklin, N. J		
1862	"	"	Garnet (Colophonite) and Rhodonite (Fowler-	1	"		
1863	"	"	Brown Hematite	2	Friedensville, Pa		
1864	"	"	Calamine	1	"		
1865	"	"	Epidote on Orthoclase	1	New York City		
1866	"	"	"Scapolite"	1	Lewis Co. N. J		
1867	"	"	Brookite	2	Arkansas		
1868	"	"	Native Copper	1	Marqueette Co. Mich		
1869	"	"	Calamine	1	Bethlehem, Pa		
1870	"	"	Magnesite (Brennerite)	1	Massachusetts		
1871	"	"	Limonite and Smithsonite	1	Franklin, N. J		
1872	"	"	Niccoliferous Pyrrhotite	1	Lancaster Co. Pa		
1873	"	"	Calcite (Argentine) and Serpentine	1	Montville. N. J		
1874	"	"	Enstatite (Bronzite)	1	Texas, Lancaster Co. Pa		
1875	"	"	Ægirite	1	Hot Springs, Ark		
1876	"	"	Hydromagnesite	3	Lancaster Co., Pa		
1877	"	"	Jadeite	2	Easton, Pa		
1878	"	"	Domeykite	1	Chili, S. A		
1879	"	"	Copper in calcite	1	Lake Superior		
1880	"	"	Hydrodolomite (Pennite)	1	Lancaster Co. Pa		
1881	"	"	Ripidolite (Clinochlore)	1	Franklin, N. J		
1882	"	"	Witherite on Water Lime	7	Rondout, N. Y		Only American locality
1883	"	"	Barite, Malachite and Quartz	1	Cheshire, Ct		
1884	"	"	Manganite	1	Nova Scotia		
1885	"	"	Malachite in Ochre	1	Maryland		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1886	Nov. 1876	Geo. F. Kunz	Flesh-colored Quartz Rock	1	Burlington, Vt.		
1887	"	"	Pele's Hair	Indf	Sandwich Islands		
1888	"	"	"Mica"	3	Franklin, N. J		
1889	"	"	Datolite (Oil green variety)	1	Bergen Hill, N. J		
1890	"	"	Prehnite with vein of "Stevensite"	1	"		
1891	"	"	Gœthite (Lepidocrocite)	1	Chestnut Hill, Pa.		
1892	"	"	Tourmaline	1	Chester, Mass.		
1893	"	"	Red Hematite	1	Franklin, N. J.		
1894	"	"	Graphite	35	New Jersey		
1895	"	"	Arsenopyrite (Mispickel)	1	Roxbury, Ct.		
1896	"	"	Dendrite	1	Franklin, N. J.		
1897	"	"	Feldspar on Trap	1	Bergen Hill, N. J		
1898	"	"	Gold in Quartz	1	California		
1899	"	"	Seybertite (Clintonite) and Chalcopyrite	1	Franklin, N. J		
1900	"	"	Epidote, Orthoclase and Copper	1	Lake Superior		
1901	"	"	Siderite	1	England		
1902	"	"	Fluorite	1	Mine Hill, Franklin, N.J		
1903	"	"	Penninite	1	Lows Mine, Tex. Lan. Co		Lows Mine
1904	"	"	Green Quartz	1	Staten Island N.J. [Pa		
1905	"	"	Zircon on Feldspar	1	Diana N. J.		
1906	"	"	Magnesite	1	Hoboken N. J.		
1907	"	"	Sodalite	1	Salem, Mass. [N. J.		
1908	"	"	Willemite	1	Passaic Mine, Franklin,		
1909	"	"	Orthoclase and Epidote	1	New York City		
1910	"	"	"Mica"	1	Chesterfield, Mass.		
1911	"	"	Aragonite	2	Franklin, N. J.		
1912	"	"	Turgite (Hydrohematite)	2	Chestnut Hill, Pa.		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained.		Name.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1913	Nov. 1876	Geo, F. Kunz	Pectolite and Datolite	1	Bergen Hill, N. J		
1914	"	"	Goethite (Lepidocroclte)	1	Chestnut Hill, Pa		
1915	"	"	Magnetite (Native magnet)	1	Union Town, N. J		
1916	"	"	Ruby zinc, Dialogite and "Sussexite"	1	Franklin, N. J		
1917	"	"	Brookite (Arkansite)	1	Magnet Cove, Ark		
1918	"	"	Apophyllite and Stilbite	1	Bergen Hill, N. J		
1919	"	"	Apophyllite and Datolite	2	" "		
1920	"	"	Apophyllite (modified)	1	" "		
1921	"	"	Laumontite	2	" "		
1922	"	"	Titanite (Sphene)	1	Amity, N. Y		
1923	"	"	Tourmaline	1			
1924	"	"	Fossiliferous Hematite	1	Oneida, N. Y		
1925	"	"	Analcite, Apophyllite and Natrolite	1	Bergen Hill, N. J		
1926	"	"	Rhodonite	2	Cummington, Mass		
1927	"	"	Muscovite	2	New Hampshire		
1928	"	"	Rhodonite (Cummingtonite)	1	Cummington, Mass		
1929	"	"	Chrysocolla and green quartz	1	Chili, S. A		
1930	"	"	Melanterite (native copperas)	1	Staten Island, N. Y		From Iron mine
1931	"	"	Copper on quartz	1	Lake Superior, Mich		Central mine
1932	"	"	Garnet (Colophonite)	1	Franklin, N. J		
1933	"	"	Quartz (Silicified wood)	1	Southern Georgia		Not found in any other local-
1934	"	"	Wenerite (Lilac Scapolite)	1	Bolton, Mass		ity and not described in the
1935	"	"	Garnet [stone.	1	New Jersey		books. Very handsome when
1936	"	"	Calcite (concretionary marble) on fetid lime-	1	Holyoke, Mass		polished across the cut of the
1937	"	"	"Montebrasite."	1	Montebras, Creiese Fr.		concretions.
1938	"	"	Gold and Silver ore [spar.)	1	East Creek, N. J		Belden's Mine.
1939	"	"	Calcite (dog-tooth spar) and Dolomite (Pearl	1	Lockport N. Y		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality	Formation	Collector and Remarks.
	When.	Whence.					
1940	Nov. 1876	Geo. F. Kunz	Datolite (in small crystals)	1	Bergen Hill, N. J		
1941	"	"	Lepidolite	1	Alterberg, Saxony		
1942	"	"	Calcite	1	Warwick, N. Y		
1943	"	"	Slag from Furnace	1	Patterson, N. J		
1944	"	"	Calcite	1	Bellville, N. J		From old copper mine.
1945	"	"	Iridescent Pyrite	1	Scales Mound, Galena Ill		
1946	"	"	Amphibole (actinolite)	1	Black Horse, Del		
1947	"	"	Amphibole (actinolite)	2	63rd St. New York City.		
1948	"	"	Orthoclase (Amazon stone)	1	Mineral Hill, Pa		
1949	"	"	Calcite, Pyrite and Specular iron	1	Antwerp, N. Y		
1950	"	"	Amygdaloid containing zeolites	1	Poonah. Hindostan		
1951	"	"	Gangue rock of Cassiterite (Tinstone)	1	Durango, Mexico		
1952	"	"	Opal	1	Rocky Mountains		
1953	"	"	Sphalerite (with Bitumen and Galenite)	1	Oronogo, Mo		
1954	"	"	Topaz (yellow)	1	Brazil, S. A		
1955	"	"	Quartz coated with Smithsonite (carb of zinc.)	1	Chatham. N. Y		
1956	"	"	Opal	1	Mexico		
1957	"	"	Apophyllite	1	Bergen Hill, N. J		Changing to Thomsonite.
1958	"	"	Staurolite	1	Lisbon, N. Hampshire		
1959	"	"	Chrysolite (Olivine)	1	Dries Eifel, Europe		
1960	"	"	Quartz	1	Governeur, N. Y		Without lateral planes,
1961	"	"	Quartz	1	Antwerp, N. Y		Without lateral planes.
1962	"	"	Topaz (pink)	1	Brazil, S. A		
1963	"	"	Gold	1	Virginia		
1964	"	"	Siderite and quartz in Geode....[Specular iron.	1	Illinois		
1965	"	"	Quartz without lateral planes and Hematite,	1	Cumberland, Eng		
1966	"	"	Quartz and chalcopyrite	1	Ellenville, N. J		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Seiral Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1967	Nov. 1876	Geo. F. Kunz	Calcite (Dog-tooth Spar)	1	Rossie, N. Y.		Doubly terminated
1968	"	"	Pectolite	3	Bergen Hill, N. J.		Friable
1969	"	"	"Zonochlorite"	4	Hud. Bay Co., Ter. B. A.		
1970	"	"	Cryst. Samarskite with Xenotime	1	North Carolina		
1971	"	"	Smithsonite and Sphalerite (Blende)	1	Bethlehem, Pa.		
1972	"	"	Graphite	2	Ticonderoga, N. Y.		
1973	"	"	Wad	1	Near Franklin, N. J.		
1974	"	"	"Stevensite," Datolite and Natrolite	1	Bergen Hill, N. J.		
1975	"	"	Sphalerite (Blende)	2	Oronogo, Mo.		Showing cleavage
1976	"	"	Amphibole (Asbestus)	1	Staten Island		
1977	"	"	Serpentine (Picrolite)	1	Franklin, N. Y.		
1978	"	"	Serpentine (Picrolite)	2	Roseville, N. J.		
1679	"	"	Calcite (Stalactite)	1	Mammoth Cave, Ky.		
1980	"	"	Opal (Cacholong)	10	Georgia		
1981	"	"	Cyanite (Rhætizite)	1	Germany		
1982	"	"	"Chrome Sand"	Ind	Media, Pa.		
1982	"	"	Quartz	4	Gouverneur, N. Y.		Without lateral planes
1984	"	"	Chlorastrolite	Ind	Isle Royale, Lake Sup.		
1985	"	"	Quartz (Carnelian)	1	Germany		
1986	"	"	Corundum (Emery)	2	Chester, Mass.		
1987	"	"	Galenite	4	Oronogo, Mo.		
1988	"	"	Galenite	1	Oronogo, Mo.		
1989	"	"	Cuprite	8	Chessy, France		
1990	"	"	Andalusite (Chiastolite, or Macle)	1	Massachusetts		
1991	"	"	Gold Quartz	1	California		
1992	"	"	Tephroite	4	Franklin, N. J.		
1993	"	"	Silver and Gold	1	Colorado		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		Name.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1994	Nov. 1876	Geo. F. Kunz	Magnetite (Loadstone)	75	Magnet Cove, Ark		
1995	“	“	Magnetite (Sand) [(Jeffersonite)	1	Port Ontario, N. Y.		
1996	“	“	Brown Garnet and Iron Garnet on Pyroxene	1	Franklin, N. J.		
1997	“	“	Orthoclase (Chesterlite)	1	Chester Co., Pa.	[group	
1998	“	“	Gypsum (Selenite)	1	Lockport, N. Y.	Niagara	
1999	“	“	Crystallized Pectolite	10	Bergen Hill, N. J.		
2000	“	“	Laumontite and Crystallized Pectolite	3	Bergen Hill, N. J.		Very rare
2001	“	“	Wulfenite	1	Tecoma Mine, Utah		
2002	“	“	Quartz (Yellow Jasper)	1	California		
2003	“	“	Calamine, Sphalerite and Greenockite	2	Granby, Mo.		
2004	“	“	Chlorastrolite	2	Isle Royal, Lake Sup.		Rare, in rock
2005	“	“	Sphalerite (Blende) and Quartz	1	Phœnixville, Pa.		
2006	“	“	Black Tourmaline	1	Kingsbridge, N. Y. City		
2007	“	“	Zincite (with Calcite)	1	Franklin, N. J.		
2008	“	“	Brucite (Nemalite)	1	Hoboken, N. J.		
2009	“	“	Amphibole (Hornblende) in Quartz	2	Chester, Mass.		
2010	“	“	Zaratite	1	Wood's Mine, Lan. co. Pa		
2011	“	“	Epidote	1	Massachusetts		
2012	“	“	Orthoclase (Flesh colored Feldspar)	2	New York City		
2013	“	“	Oligoclase	1	New York City		
2014	“	“	Seybertite (Clintonite)	1	Franklin, N. J.		
2015	“	“	Zincite (with Calcite) “Sussexite”	1	Franklin, N. J.		
2016	“	“	Greenockite	1	Granby, Mo.		Of the following Nos. to No. 2063,
2017	“	“	Siderite	1	Roxbury, Conn.		nearly all were collected by
2018	“	“	Gmelemite	1	Bergen Hill, N. J.		[Chas. Clifton, about 1860, from
2019	“	“	“Feldspar”	1	Chester, Pa.		near Easton, Pottsville, and the
2020	“	“	Limonite	24	Near Easton, Pa.		coal and iron district bordering.

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

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Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2021	Nov. 1876	Geo. F. Kunz	Limonite [Fibrous]	5	Near Easton, Pa		
2022	"	"	Limonite	9	PompeysMarsh nrE'st'n		
2023	"	"	Limonite [Stalactitic]	1	Easton, Pa		
2024	"	"	Limonite	4	Franklin, N. J		
2025	"	"	Limonite	2	Pottsville, Pa		
2026	"	"	Limonite	4	Altoona Pa		Alleghany Furnace
2027	"	"	Limonite	5	Chestnut Hill, Pa		
2028	"	"	Limonite	2	Bennington Furnace,Pa		
2029	"	"	Limonite [Septaria of]	1	Hopewell, Pa		
2030	"	"	Limonite [fossil]	2	Bedford, B. Co. Pa		
2031	"	"	Limonite [fossil]	3	Hopewell, Pa		
2032	"	"	Limonite [fossil]	1	Columbia Co. Pa		
2033	"	"	Limonife [fossil]	1	Near Altoona, Pa		
2034	"	"	Hematite [Red]	3	Near Easton, Pa		
2035	"	"	Hematite [brown]	3	Pompey's Marsh, Pa		
2036	"	"	Hematite [brown]	2	Bennington Furnace,Pa		
2037	"	"	Hematite [fossil]	1	Near Easton, Pa		
2038	"	"	Hematite [fossil]	12	Brush Hill, Pa		
2039	"	"	Hematite [fossil]	1	Henry Furnace, Pa		
2040	"	"	Hematite [fossil]	2	Bennington Furnace,Pa		
2041	"	"	Hematite [fossil]	3	Altoona, Pa		
2042	"	"	Hematite [fossil]	1	Lewiston, Pa		
2043	"	"	Hematite [fossil]	1	Mt. Savage, Pa		Camberland Furnace
2044	"	"	Hematite	1	Danville, Pa		
3045	"	"	Siderite	4	Hopewell Furnace, Pa.		
2046	"	"	Siderite [Shale]	1	Trantbree Tunnell, Pa.		
2047	"	"	Siderite and Limonite	1	Hopewell Furnace, Pa.		

Catalogue of Specimens Rigistered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
							23
2048	Nov. 1877	Geo. F. Kunz....	Siderite..........	1	Hopewell, Pa..........	....	Siliceous..........
2049	"	"	Siderite..........	2	Easton, Pa..........	....	....
2050	"	"	Hematite (Specular Iron]..........	2	Lake Superior Region..	....	....
2051	"	"	Hematite (Specular Iron)..........	1	Near Pottsville, Pa....	....	....
2052	"	"	Hematite (Specular Iron)..........	2	Near Easton, Pa.......	....	....
2053	"	"	Hematite (Specular Iron)..........	1	Pottsville, Pa..........	....	....
2054	"	"	Pipe Ore..........	1	Pottsville, Pa..........	....	Bay Ridge Mountain Coal Field
2055	"	"	Calcite and Siderite..........	1	Easton Pa..........	....	....
2056	"	"	Magnetite..........	4	Mt. Hope, N. J.......	....	....
2057	"	"	Magnetite..........	2	Dover, N. J..........	....	....
2058	"	"	Magnetite (Magnetie Iron)..........	1	Cornwall,Leban'n co Pa	....	....
2059	"	" ...	Magnetite and Pyrite..........	2	" "	....	....
2060	"	"	Magnetite and Pyrite..........	1	" "	....	....
2061	"	"	Pyrite..........	1	Near Easton, Pa........	....	....
2062	"	"	Magnetite ?..........	3	Cornwall,Leban'n co Pa	....	....
2063	"	"	Iron Ore..........	1	Bedford county, Pa.....	....	....
2064	"	"	Sodalite with Cancrinite and Lepidomelane....	1	Litchfield, Me..........	....	....
2065	"	"	Peculiar Slags from Furnaces..........	2	Alleghany, Pa..........	....	Same Note Applies as to No. 2020
2066	"	"	Calcite (Flux)..........	1	Easton, Pa..........	....	" " " " 2020
2067	"	"	Slag Crystals from Furnaces..........	1	Easton, Pa..........	....	" " " " 2020
2068	"	"	Mineral Coal (Anthracite)..........	2	Pottsville, Pa..........	....	" " " " 2020
2069	"	"	Beryl (Aquamarine)..........	1	Liberia..........	....	....
2070	"	"	Cassiterite (Stream Tin) and Topazes..........	Indf	Durango, Mexico.......	....	....
2071	"	"	Cassiterite (Stream Tin)..........	Indf	Durango, Mexico.......	....	....
2072	"	"	....	1	....	....	Believe it Artifi. (G. F. K.) As 2020
2073	"	"	Siderite (Carb. of Iron, Shale..........	2	Mt. Savage, Pa.........	....	Same Note Applies as to 2020...
2074	"	"	....	1	Summit Furnace, Pa...	....	" " " 2020...

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2075	Nov. 1876	Geo. F. Kunz.....	"Fire Clay".....	2	Mt. Savage, Pa.........	....	Same note applies as to 2020....
2076	"	"	Coal Shale.....	1	Pottsville, Pa..........	....	Same note as 2020, about 400 feet above main view.........
2077	"	"	Limestone Ore (No. 1).....	1	"	....	The following six are from a mine near Pottsville..........
2078	"	"	"Slate Pins" (No. 2).....	1	"	....	About 4 feet above main vein..
2079	"	"	"Sandy Pin" (No 3).....	1	"	....	" 31 " " ..
2080	"	"	"Lime Pin" (No. 4).....	1	"	....	" 20 " " ..
2081	"	"	"Upper Bastard (No. 5).....	1	"	....	" 17 " " ..
2082	"	"	"Pin Vein of Ore'. (No. 6).....	1	"	....	" 17 " " ..
2083	"	"	(No. 7).....	1	"	....	With 4 fluid cavities marked wth
2084	"	"	Quartz	1	Near Hot Springs, Ark.	....	........................[ink.
2085	"	"	Calamine (blue)	2	Franklin, N. J.........	....	Crystal showing "O plane" of
2086	"	"	Calcite	1	Bergen Hill, N. J.......	....	........................[Dana
2087	"	"	Microlite and Uraconite (Uranochre).....	1	North Carolina.........	....	....
2088	"	"	Chloritoid (Masonite).....	1	Smithfield, L. Island...	....	....
2089	"	"	Apatite, Pyrite and Graphite.....	1	Franklin, N. J.........	....	....
2090	"	"	Quartz and Epidote	1	" "	....	....
2091	"	"	Calcite coated with quartz (Chalcedony).....	1	Bergen Hill, N. J	....	....
2092	"	"	Decomposing Pectolite and Prehnite.....	1	" "	....	....
2093	"	"	" Chalcopyrite.....	1	" "	....	....
2094	"	"	Pseudo Talc (Steatite).....	1	" "	....	....
2095	"	"	Franklinite and Calcite.....	2	Franklin, N. J.........	....	....
2096	"	"	Franklinite and Calamine.....	1	" "	....	....
2097	"	"	Wernerite (Scapolite) and Apatite.....	1	" "	....	....
2098	"	"	Oligoclase.....	1	New York City.........	....	....
2099	"	"	Amphibole (Asbestus).....	5	Franklin, N. J.........	....	....
2100	"	"	Labradorite	1	Louis County, N. Y.....	....	....
2101	"	"	Graphite and some other mineral.....	1	New York.............	....	....

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
2102	Nov. 1879	Geo. F. Kunz	Catlinite	1	Pipestone Co., Minn.		
2103	"	"	Quartz containing fluid and mineral coal (Anth.)	1	Herkimer Co., N. Y.		
2104	"	"	Barite	1	Franklin, N. J		
2105	"	"	Spodumene	1	Maine		
2106	"	"	Zincite and Calcite Spartaite	1	Franklin, N. J		
2107	"	"	Garnet on Zincite (Schist)	4	Franklin, N. J		
2108	"	"	Franklinite, Zincite and Calcite (Spartaite)	1	Franklin, N. J		
2109	"	"	"Mica"	1	Chester, Pa		
2110	"	"	Pyrite (octahedral)	2	Bergen's Hill, N. J		
2111	"	"	Quartz (Amethyst, doubly terminated)	6	Brazil		
2112	"	"	Perofskite	4	Magnet Cove, Ark		
2113	"	"	Pyroxene (in lava)	15	Vesuvius, Italy		
2114	"	"	Brucite	2			
2115	"	"	Calcite (Stalactite)	2			
2116	"	"	Serpentine	1	St. Lawrence Co., N. Y.		
2117	"	"	Calamine on Sphalerite	1	Granby, Mo		

INDEX TO THE GEOLOGICAL REPORT.

ERRATA.

On page 3, insert "the" before Geological.
On page 3, for "Dec. 31, 1877," read May 25, 1878.
On page 27, fifth line from top, for "lining" read limy.
On page 28, first line from top, for "6.44" read 6.21.
On page 28, first line from top, for "32.287" read 31.287.
On page 28, second line from top, last column in table, for "0" read 9.
On page 43, for "Reconnoisences" read Reconnoissances.
On page 48, eighth line from bottom, for "moutone-ed" read *moutonne-ed.*
On page 53, second line from bottom, for "scantly" read scantily.
On page 55, third line from bottom, for "60" read 27.
On page 59, twelfth line from bottom, for "nolithic" read neolithic.
On page 68, third line from the top, for "Thus" read This.
The 69th and 70th pages should exchange places.
On page 75, at bottom, add Ilex verticellata, *Gray*, Black alder.
On page 82, fourteenth line from top, for "Chæteets" read Chætetes.
On page 83, twenty-fourth line from the bottom, for "organized" read recognized.
On page 99, seventeenth line from bottom, for "southwestern" read southeastern.
On page 123, third line from top, for "exposuse" read exposure.
On page 123, sixth line from top, for "mills" read miles.
On page 129, fourth line from bottom, for "62" read 52.
On page 201, strike out "Rock on which Duluth is built."
On page 216, the words "with 4 fluid cavities marked with ink," and "crystal showing 'o plane of Dana," should each be placed a line lower on the page.