THE

GEOLOGICAL AND NATURAL HISTORY

SURVEY OF MINNESOTA.

THE THIRD ANNUAL REPORT

FOR THE YEAR 1874.

[SECOND EDITION.]

BY N. H. WINCHELL, STATE GEOLOGIST.

SUBMITTED TO THE PRESIDENT OF THE UNIVERSITY Dec. 31, 1874

MINNEAPOLIS:
HARRISON & SMITH, PRINTERS.
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[NOTE—This edition is identical with the original, excepting the correction of typographical errors. As this report was published originally only as part of the regents' report, it has the paging of that report.—*N. H. W.*]

ADDRESS

To the President of the University:

The regular work of the geological and natural history survey of the state was interrupted during the season of 1874. The condition of the new buildings at the University has been such that no chemical work could be satisfactorily done, and very little has been accomplished. The same cause deranges the geological laboratory and delays the unpacking and examination of specimens. Not a room has been available during the season for opening and unpacking boxes.

At the close of the spring term in the University, the board of regents granted the request of Col. Wm. Ludlow, U. S. T. E., and allowed the departure of the state geologist with the expedition of general G. A. Custer to the Black hills of Dakota. He was absent during July and August. This again broke in upon plans that had been laid for a vigorous prosecution of the field-work of the state survey. The regents, however, rightly regarded the exploration and development of the Black hills of Dakota as largely tributary to the state of Minnesota, while the accessions that would be made to the University museum were likely to more than repay the expense and time required. The young state of Minnesota also may claim the honor of sending the first geologist through the unexplored interior of the Black hills, so long involved in mysterious and legendary uncertainty. A report on the geology of the route and of the Black hills of Dakota is herewith transmitted.* The problems that have long been debated by geologists concerning the relative ages of certain sandstones of the Lower Silurian

*By order of the Board of Regents this report has been transmitted to Col. Wm. Ludlow.

receive some light by the geological examination of the Black hills, and some of the detailed sections of those rocks, given in the accompanying report, are exceedingly interesting. Every facility, except a sufficiency of time, was placed at my disposal by Gen. G. A. Custer, through Col. Ludlow, for the prosecution of the geological examinations. The expedition, being restricted to sixty days, and with provisions only for that length of time, was compelled to pass over the ground faster than was conducive to a full knowledge of the geology of the region traversed.

After my return from the Black hills, delayed somewhat by sickness in my family, and by the necessary preliminary work for the accompanying report, I had only time to complete the examination of two counties. I chose Freeborn and Mower, those being next the state of Iowa and within the possible coal area of Minnesota. A local interest had been excited in Freeborn county by the development of a shaft at Freeborn which was reported to go through several feet of good coal. This region has been thoroughly explored and the full details are contained in the accompanying report on that county. I am greatly obliged to Wm. Morin, Esq., of Albert Lea, for guidance and assistance in the survey of Freeborn county, and to Hon. A. A. Harwood, of Austin, for the same in making the survey of Mower county.

Various parties have submitted to the survey, for analysis, ores from the northern part of the state, and have applied for assistance in exploring those portions of the northern part of the state that are known to afford indications of the precious and useful metals. In some cases these samples of ores have been received and analyses have been procured, through the agency of the survey, by chemists abroad; but it has not been possible to afford any guidance to persons applying for assistance in field exploration. It is exceedingly desirable that the chemical laboratory, now nearly completed, be made available for the work of the survey, as soon as possible.

In the early part of the season, a pamphlet on *Peat for domestic fuel*, was prepared, at my request, by Prof. S. F. Peckham, the chemist of the survey, for general distribution. Several hundred copies have been gratuitously distributed to those citizens of the state interested in the subject of peat fuel, and it was printed in full by the *Farmer's Union*, the principal agricultural newspaper of the state. It was hoped thereby to give the needed information concerning the nature and outward characters of peat, to the

farmers and others living in the treeless districts, that would enable them to discover and to make use of it as a common fuel where it exists, if they should feel so disposed.

During the season of 1873 but very little good peat was found in the counties of Jackson, Cottonwood and Nobles; but in the examination of Freeborn county, during the past season, inexhaustible quantities of the best qualities of fibrous peat were met with. Mower county contains very little.

Very respectfully,

N. H. WINCHELL.

THE UNIVERSITY OF MINNESOTA,
Minneapolis, Dec. 31, 1874.

REPORT ON THE GEOLOGY OF FREEBORN COUNTY.

Situation and area.

Freeborn county borders on the state of Iowa, and is very near the center of the southern boundary line of Minnesota. It has the form of a rectangle, having a length, east and west, of five government towns, and north and south, a width of four, making an area of 720 square miles, or 449,235.63 acres, after deducting the areas covered by water.

Natural drainage.

With the exception of Freeborn, Hartland, and Charleston townships, the surface drainage is toward the south and southeast. The county embraces the head waters of the Shellrock and Cedar rivers of Iowa, and those of the Cobb river, which joins the Minnesota toward the north. Hence it lies on the watershed between two great drainage slopes. For the same reason none of its streams are large; the Shellrock, where it leaves the state, being its largest. The streams have not much fall, but afford some water-power, which has been improved in the construction of flouring mills. Such are found at Albert Lea and at Twin Lakes. In these cases the body of water confined in the upper lake serves as the water-head and reservoir, the mills being constructed near their outlets. There is also an available water-power at Shellrock village, but its use would cause the flooding of a large body of land adjoining the river.

Surface features.

The surface of the county, although having no remarkable and sudden changes of level, yet is considerably diversified as a rolling prairie, more or less covered with sparse oaks and oak bushes. The plats of the United States surveyors,

Explanation

Marsh
Timber
Public Roads
Railroad

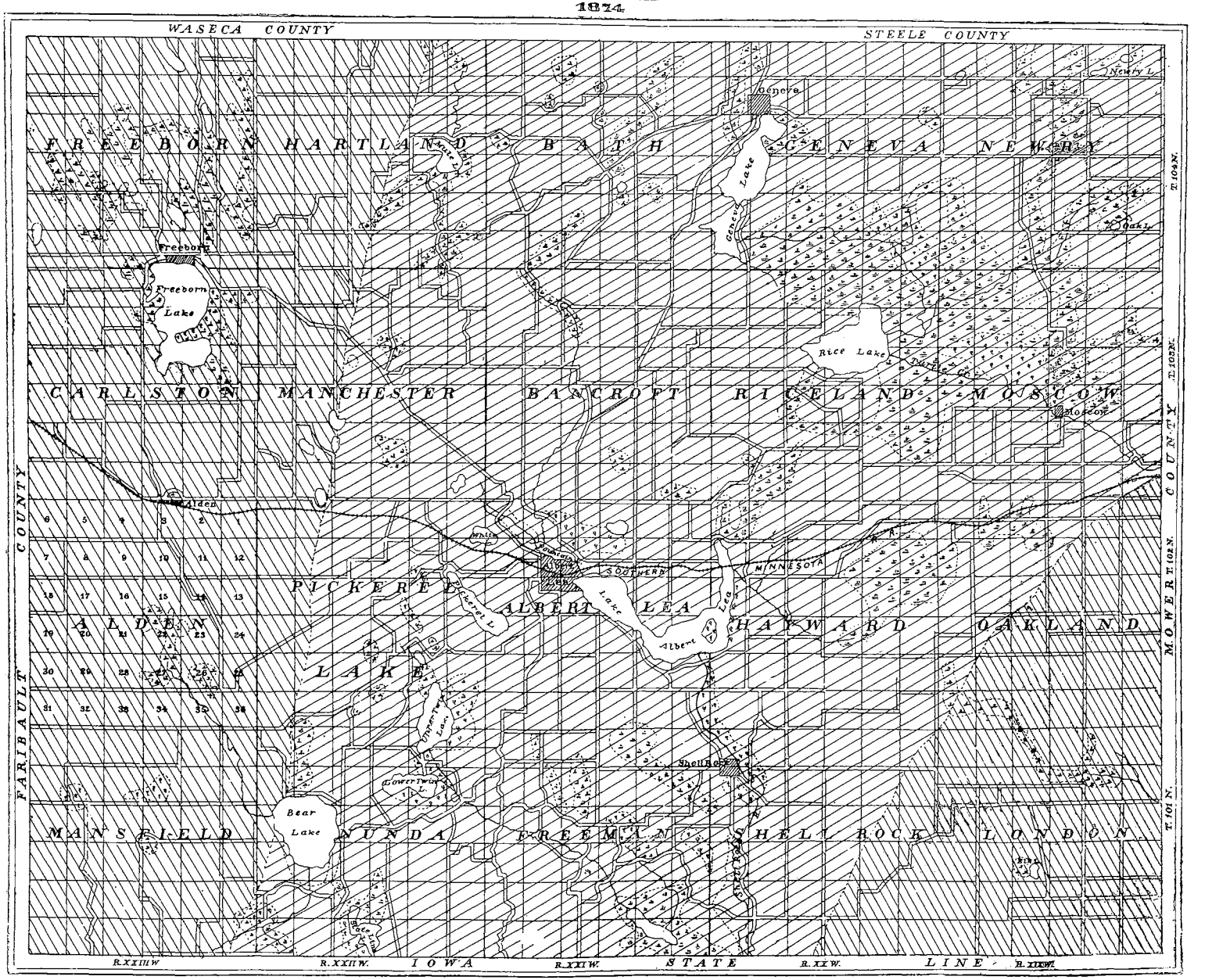
GEOLOGICAL MAP OF THE COUNTY OF FREEBORN

BY N.H. WINCHELL
1874.

The Geological and Natural History Survey of Minnesota. Third Annual Report.

Explanation

Cretaceous.
Devonian.



on file in the register's office at Albert Lea, indicate considerably more area covered with timber, or as "oak openings," when the county was surveyed by them, than is now the case. The following minutes are based on an examination of their plats, and will give a pretty correct idea of the distribution of the oak openings and the prairie tracts throughout the county.

London. The most of this township is prairie, a belt of oak openings and timber entering it from the north, about three miles wide, in the center of the town, and extending to the center, bearing off to the SE., and terminating in sec. 24. The magnetic variation throughout the town was, when surveyed (1854) from 8° 20′ to 10° 42′, the greatest being in secs. 33 and 34.

Oakland. A little more than a half of this township consists of oak openings, an area in the eastern half only being prairie, with a small patch also in sec. 31. Two large sloughs cross the town, one through sections 30, 31 and 32, and the other through sections 4, 5, 8, 7 and 18. Magnetic variations about 9°, varying from 8° 12′ to 10° 8′, in 1854.

Moscow. Nearly the whole of this township is taken up with oak openings and marshes. Turtle creek crosses it from NW. to SE. A large portion of the northern half of the town is a floating marsh, containing a great quantity of peat. Mag. var. from 9° 20′ to 10° 20′, in 1854.

Newry. There is a small patch of prairie in the northeast part of this town, secs. 1, 12, 13 and 24, and a small area in secs. 20 and 21. There is another in the NW. corner, embracing sections 6 and 7, and parts of 5, 8 and 18. The rest is openings and marsh, particularly of marsh in the SW. corner. Mag. var. 8° 20′ to 9° 40′, in 1854.

Shellrock. A belt about 1½ miles wide along the west side of this town, accompanying the Shellrock river, constitutes the only openings or timbered portion, the rest being prairie. This district also comprises some marsh, viz., secs. 19 and 31. Th first house in the county was built in sec. 33 in this town, in the SW. quarter. Mag. var. 8° 45′ to 10° 15′ in 1854.

Hayward. A wide belt of prairie occupies about two-thirds of this town, running N. and S. through the center. On the west of this is a rolling tract embracing a portion of lake Albert Lea and some tributary marshes, while on the east a large marsh covers sections 12 and 14, and portions of 13, 11, 15, 22 and 23. There is also a prairie tract in sec. 1.

Riceland. This township is about equally divided between prairie, openings and marsh, the first being in the south central portion, the second in the northwest and central, bordering on Rice lake, and the marsh in the northeastern part of the town. Mag. var. from 8° 45′ to 10° 30′.

Geneva. There is but little prairie in this town, the southern portion being comprised in a large marsh which is crossed by Turtle creek, the outlet of Walnut lake. The central portion is occupied by oak openings which also extend to the NW. and W. boundaries. The prairie is in the northern and eastern portions. Mag. var. 9° 10′ to 10° 23′ in 1854.

Freeman. This township comprises no prairie. It is mostly devoted to oak openings, but a series of marshes, drained by the tributaries of the Shellrock, that cross it toward the SE. take up a considerable area in the central and eastern portions. Mag. var. 9° to 10° 40′ in 1854, the greatest being in sec. 31.

Albert Lea. This township is nearly all taken up with oak openings, but a few small marshes, trending NW. and SE., are found in different portions. There is also a small patch of prairie in sec. 6, and another in the SE. corner of the county. The western arm of Albert Lea lake, through which the Shellrock river runs, is in the central and eastern part of this town, and adds greatly to the variety and beauty of its natural scenery. Pickerel lake is also partly in this township. Mag. var. 8° 46′ to 10° 08′ in 1854.

Bancroft. A little more than one-fourth of this township is prairie, situated in the center and southwestern portions. The rest of the town is covered with oak openings. The source of the Shellrock is in the NW. part of this town. Mag. var. 8° 50′ to 10° 15′ in 1854.

Bath. An area of openings comprising about half of this town in the central and eastern portion, is nearly surrounded by a belt of prairie. Small marshes are scattered through the town. Mag. var. 8° 45′ to 10° 35′ in 1854.

Nunda. This town is also mostly openings, but an area of prairie occurs in secs. 4, 5, 9 and 3, and another lies southwest of Bear lake. Considerable marsh land is embraced within the area of openings. Mag. var. in 1854 10° 5′ to 12° 15′, the latter in sec. 31.

Pickerel. The west half of this township is prairie, and the eastern is devoted to openings with lakes and marshes. Mag. var. 9° 45′ to 11° 50′ in 1854.

Manchester. About one-half of this town is prairie, the

remainder being oak openings. The prairie lies in the northwestern and southern portions. Small marshes occur both in the prairie and openings. Mag. var. 10° to 12° 15′ in 1854.

Hartland. This town is almost entirely composed of prairie, the only timber being about Mule lake, and in the southern portions of secs. 34, 35 and 36. There is not much marsh in the town. Mag. var. 9° 45′ to 12° 25′ (1854).

Mansfield This town is nearly all prairie, a small patch of oak openings occurring in secs. 3, 10 and 15. The NW. part of the township is rolling and the SE. is level and wet with marshes. Mag. var. 11° 30′ to 13° 40′ (1858).

Alden. This town is all prairie, with scattered small marshes. Mag. var. 11° 27′ to 13° 15′ (1854).

Charleston. This town is all prairie, except a narrow belt of sparce timber about Freeborn lake. Long narrow marshes spread irregularly over the central and eastern portions of the town. In the SE. quarter of sec. 36 there is also a small area of sparse timber. Mag. var. 11° 13′ to 13° (1854).

Freeborn. In this town there is a little sparse timber about the north ends of Freeborn and Spicer lakes, and a little adjoining Spicer lake on the east. There are also some openings in sec. 26, where the arms of the marsh protect the timber from the prairie fires. The rest is of prairie with spreading marshes. Mag. var. (1854) 11° 55′ to 12° 50′.

North and west of Albert Lea is a very broken and rolling surface of sparse timber. This tract consists of bold hills and deep valleys wrought in the common drift of the country. On some of these hills are granitic boulders, but the country generally does not show many boulders. The drift is generally, in this broken tract, a gravelly clay. In some of the street cuts for grading a gravel is found, containing a good deal of limestone.

A great many of the marshes of the county are surrounded with tracts of oak openings, a fact which indicates that the marshes serve as barriers to the prairie fires. Such marshes are really filled with water, and quake with a heavy peat deposit on being trod on. They are very different from those of counties further west, as in Nobles county, which, in the summer, are apt to become dried, and are annually clothed with a growth of coarse grass, which feeds the fires that pass over the country in the fall. As a gene-

ral rule, but little or no grass grows on a good peat marsh.

The contour of the surface of the country is further exemplified by the following elevations obtained from lines run by railroad surveys. They were furnished by Wm. Morin, Esq., of Albert Lea.

Elevations taken from a preliminary survey made in July, 1870, through Freeborn county, Minn., by Wm. Morin:

Commencing on the state line (south), 930 feet east of the ¼ stake, on south side of section 32, T. 101, R. 20; thence north to Shellrock City, on sec. 6, T. 101, R. 20; thence N. 40° W. to Albert Lea, on sec. 8, T. 102, R. 21; thence N. 40° E. to Geneva, on sec. 7, T. 104, R. 20, and thence N. to the Steele county line.

	Above ocean. Feet.	
Station No. 1—At point 930 feet E. of ¼ stake, on sec. 32, T. 101, 20.	1,232	
" 100	1,241	
" 190	1,219	
" 199-10—Water in Shellrock river, east bank	1,217	
" 200-80— " " " west bank	1,217	
" 202	1,232	
" 300—Shellrock City (town plat)	1,241	
" 494—Summit between Shellrock and Albert Lea.	1,333	11 miles
" 654—Albert Lea (town plat)	1,263	
Lake Albert Lea	1,221	
" 1064—Summit at Clark's Grove	1,334	
Geneva lake (or Walnut lake)	1,234	
" 1330—At Steele county line, sec. 5, T. 104, 20	1,226	

Elevations obtained from O. D. Brown, Esq., engineer on S. M. R. R.:

	Above the ocean. Feet.
Milwaukee and St. Paul R. R.—Top of rail at Ramsey	1,233
Water in Turtle creek—4 miles west of "	1,204
Oakland station—6 miles " "	1,286
Big marsh—12 miles " "	1,265
Lake Albert Lea—20 miles " "	1,221
Grade at Albert Lea depot	1,240
Jenning's summit—5 miles west of Albert Lea	1,342
Grade at Alden station—10½ miles west of Albert Lea	1,281
" " Wells " 20 " " " "	1,171

The country thus appears to contain some of the highest land in the state. Some of the counties farther west, particularly Nobles, and Mower county on the east, rise from one to two hundred feet higher. There is also a high and rolling tract in the north central portion of the state, covering Otter Tail county, which rises to about the same level, as shown by railroad profiles. The greater portion of the state, however, lies several hundred feet lower than Freeborn county.

Soil and timber.

Throughout the county the soil depends on the nature of the drift combined with the various modifying local circumstances. There is nothing in the county that can properly be designated a "*limestone soil*," or a "*sandstone soil.*" The materials of which it is composed have been transported perhaps several hundred miles, and are so abundantly and universally spread over the underlying rock that they receive no influence from it. The subsoil is a gravelly clay, and in much of the county that also constitutes the surface soil. In low ground this of course is disguised by a wash from the higher ground, causing sometimes a loam and sometimes a tough, fine clay; the latter particularly in those tracts that are subject to inundation by standing water. On an undulating prairie, with a close clay, or clayey subsoil, such low spots are apt to have a black, rich loam or clayey loam, the color being derived from the annual prairie fires that leave charred grass and other vegetation to mingle with the soil. The same takes place on wide tracks of flat prairie. In these there may be but rarely a stone of any kind—indeed that is usually the case—but below the immediate surface, a foot or eighteen inches, a gravelly clay is always met with. This at first doubtless formed the soil, the disintegrating forces of frost, rain and wind, combined with the calcining effects of the prairie fires, having reduced the stones and gravel to powder, leaving a finely pulverized substance for a surface soil. In a rolling tract of country, while the low ground is being filled slowly with the wash from the hills, and furnished with a fine surface soil, the hills are left covered with a coarse and stony surface soil. For that reason a great many boulders are sometimes seen on the tops of drift knolls. Along streams, and about the shores of lakes, the action of the water has carried away the clay of the soil and often eaten into the original drift, letting the stones and boulders tumble down to the bottom of the bank, where they are often very numerous. Along streams they are sometimes again covered with alluvium,—indeed are apt to be—but along the shores of lakes they are kept near the beach line by the action of winter ice. After a lapse of time sufficient, the banks themselves become rounded off, and finally turfed over or covered with trees. These lakes sometimes extend their limits laterally, but slowly become shallower.

This county is furnished with a number of very beautiful

lakes. These are generally in the midst of a rolling country, and some of their banks are high.

In the survey of the county the following species of trees and shrubs are noticed growing native:

Burr oak. Quercus macrocarpa *Michx.*
Red oak. Quercus rubra *L.* (This species is not satisfactorily identified.)
Aspen. Populus tremuloides *Michx.*
Elm. Ulmus americana (*Pl. clayt.*) *Willd.*
Black cherry. Prunus serotina *Ehr.*
American crab. Pyrus coronaria *L.*
Bitternut. Carya amara *Nutt.*
Black Walnut. Juglans nigra *L.*
Wild plum. Prunus americana *Marsh.*
White ash. Fraximus americana *L.*
Butternut. Juglans cinerea *L.*
Hazlenut. Corylus americana *Walt.*
Frost grape. Vitis cordifolia *Michx.*
Bittersweet. Celastrus scandens *L.*
Smooth sumach. Rhus glabra *L.*
Red raspberry. Rubus strigosus *Michx.*
Rose. Rosa blanda *Ait.*
Wolfberry. Symphoricarpus occidentalis *R. Br.*
Bass. Tilia americana *L.*
Prickly ash. Zanthoxylum americanum *Mill.*
Cornel. (Different species.)
Willow. (Different species.)
Gooseberry (prickly). Ribes cynosbati *L.*
Thorn. Crataegus coccinea *L*
Hackberry. Celtis occidentalis *L.*
Sugar maple. Acer saccharinum *Wang.*
Cottonwood. Populus monilifera *Ait.*
Soft maple. Acer rubrum *L.*
Cockspur thorn. Crataegus crus-galli *L.*
Slippery elm. Ulmus fulva *Michx.*
Black ash. Fraximus sambucifolia *Lam.*
High-bush cranberry. Viburnum opulus *L.*
Choke-cherry. Prunus virginiana *L.*
Shagbark hickory. Carya alba *Nutt.* (On M. L. Bullis' land in Moscow township, near the county line.—*A. A. Harwood.*)

Besides the foregoing, the following list embraces trees that are frequently seen in cultivation in Freeborn county:

Spruce.
Red cedar. Juniperus virginiana *L.*
Mountain Ash. Pyrus americana *D. C.*
Balsam poplar. Populus balsamifera *L.*, *Var.* candicans.
Lombardy poplar. Populus dilatata *Ait.*
Locust. Robinia pseudacacia *L.* [The locust dies out in Freeborn county.]
Hackmatack. Larix americana *Michx.*
Arbor vitae. Thuja occidentalis *L.*

The geological structure.

There is not a natural exposure of the underlying rock in Freeborn county. Hence the details of its geological structure are wholly unknown. It is only by an examination of outcrops in Mower county and in the adjoining counties of Iowa, together with a knowledge of the general geology of that portion of the state, that anything can be known of the geology of Freeborn county. In the absence of actual outcrops of rock within the county, there are still some evidences of the character of the rock that underlies the county, in the nature and position of the drift materials. There is, besides, a shaft that has struck the Cretaceous in the northwestern portion of the county, in exploration for coal.

Although the drift is heavy it lies in such positions that it shows some changes in the surface of the bed rock. It is a principle pretty well established that any sudden great alternation in the rock from hardness to softness, as from a heavy limestone layer to a layer of erosible shales, or from shales to more enduring sandstone, each stratum having a considerable thickness, is expressed on the drift by changes from a rough and rolling, more or less stony surface to a flat and nearly smooth surface, or *vice versa.* It sometimes happens that the non-outcropping line of superposition of one important formation with another, either above or below, can be traced across a wide tract of drift covered country by following up a series of gravel knolls or ridges that accompany it, or by some similar feature of the topography. Again, the unusual frequency of any kind of rock in the drift at a certain place, especially if it be one not capable of bearing long transportation, is pretty good evidence of the proximity of the parent rock to that locality.

Applying these principles to Freeborn county, we find throughout the county a great many boulders of a hard, white, compact magnesian limestone, that have been extensively burned for quicklime. These attracted the attention of the early settlers, and before the construction of the Southern Minnesota railroad supplied all the lime used in the county. Although these boulders are capable of being transported to a great distance, their great abundance points to the existence of the source of supply in the underlying bed-rock. In the drift also are frequently found pieces of lignite, or Cretaceous coal, which cannot be far transported by glacier agencies. This also indicates the existence of the Cretaceous lignites in Freeborn county. In regard to changes

in the character of the natural surface, we seen a evenly flat and prairie surface in the western tier of towns, and in the southeastern part of the county, and a hilly and gravelly tract of irregular shape in the central portion. There are two ridges or divides, formed superficially of drift, that occur in the central part of the county, one north of Albert Lea, and the other south of it, separated about eleven miles, as shown by a series of elevations from a preliminary R. R. survey by Mr. Wm. Morin, already mentioned. What may be their direction at points further removed from Albert Lea it is not possible to state with certainty, but on one side they seem to trend toward the NW. Indeed there seems to be an NW. and SE. trend to the surface features of Freeborn county generally. Such rough surfaces, and especially the ridges of drift, are more stony and gravelly than the flat portions of the county. They mark the location of great inequalities in the upper surface of the underlying rock, the exact nature of which cannot be known.

In addition to these general indications of the character of the rock of the county, the shaft sunk for coal at Freeborn, reveals the presence of the Cretaceous in that portion of the county, and examinations of the nearest exposures in the neighboring county of Iowa, disclose the Hamilton limestone of the Devonian age. This limestone is exactly like that found so abundantly in the form of boulders in Freeborn county. As the general direction of the drift forces was towards the south, and as the strike of the Hamilton in Iowa, according to Dr. C. A. White (see his map of the geology of Iowa, Final Report, 1870) is toward the N. W., there is abundant reason for concluding that that formation also extends under Freeborn county. The preliminary geological map of the state of Minnesota, published in 1872, indicates Freeborn county almost entirely underlain by the Devonian, the only exception being in the northwestern corner. How much further toward the N. W. these limestone boulders can be traced with equal abundance, the explorations of the survey have not yet revealed. The Devonian does not certainly cross the Minnesota river. Yet in McLeod county, which lies in the line of strike of the Devonian of Iowa and Freeborn county toward the N.W., on the opposite side of the Minnesota river, the same limestone boulders are very abundant, some being so large as to have been reputed rock *in situ*, and quarried as such till exhausted. The northwestern corner of Freeborn county has been regarded as underlain by a limestone of the age of the Nia-

gara, belonging to the Upper Silurian, that formation in the Northwest coming directly below the limestones of the Devonian. That may be correct; but it is certain that there is in the neighborhood of Freeborn an area of the Cretaceous, which must, in that case, overlie the Silurian limestones. This Cretaceous area is believed to extend north and south asross the west end of the county, and to be roughly coincident with the flat and prairie portion in the western part of the county, in which case it always overlaps the Devonian.

Explorations for coal.

In common with many other places in southern Minnesota, Freeborn township, in the northwestern corner of this county, has furnished, from the drift, pieces of Cretaceous lignite that resemble coal. These have, in a number of instances, incited ardent expectations of coal, and led to the outlay of money in explorations. Such pieces are taken out in digging wells. The opinion seems to grow, in a community where such fragments are found, that coal of the Carboniferous age exists in the rocks below. In sinking a drill for an artesian well, at Freeborn village, very general attention was directed to the reported occurrence of this coal in a regular bed, in connection with a "slate rock." This locality was carefully examined, and all the information was gathered bearing on the subject that could be found. The record of the first well drilled is given below, as reported by the gentleman who did the work:

1.	Soil and subsoil, clay	15 feet.
2.	Blue clay	35 feet.
3.	"Conglomerated rock," (had to drill)	2 inches.
4.	Sand and water	5 feet.
5.	Fine clay, tough, hard to drill, with gravel and limestone pebbles	60 feet.
6.	Sand and water	4 inches.
7.	"Slate rock," } Probably Cretaceous. {	7 feet.
8.	"Coal," } Probably Cretaceous. {	5 feet 4 inches
	Total depth	127 feet, 10 inches

This indication of coal induced the drilling of another well, situated 100 feet distant, toward the N. E. In this the record was as follows, given by the same authority:

1.	Soil and subsoil, clay	15 feet.
2.	Blue clay	33 feet.
3.	"Conglomerated rock"	2 inches.
4.	Sand with water, and pieces of coal	12 feet.
	Total depth	60 feet 2 inches

When the drill here had reached the "conglomerated rock" it was supposed to have reached the "slate rock," No. 7 of the previous section. The amount of coal in the sand of No. 4 was also enough to cause it to be taken for No. 8 of the previous section. Hence the boring was stopped; and having thus demonstrated the existence of a coal-bed, to the satisfaction of the proprietors, the enterprise was pushed further in the sinking of a shaft. In sinking this shaft water troubled the workmen so that at 35 feet it had to be abandoned.

Three quarters of a mile north of these drills a shaft was sunk 57 feet, but not finding the coal as expected, according to the developments of the last section above given, the explorers stopped here. In this shaft the overseer reports the same strata passed through in the drift as met with in the first well drilled, but the so called "conglomerated rock" was met at a depth of 45 feet. The sand below the "conglomerated rock" here held no water, but was full of fine pieces of coal. Before sinking the shaft at this place a drill was made to test the strata. These being found "all right" the shaft was begun. In that drill gas was first met. It rose up in the drill hole, and being ignited it flamed up 8 or 10 feet with a roaring sound. The shaft was so near the drill hole that it drew off the gas gradually, allowing the intermixture of more air, thus preventing rapid burning. From this place the exploration was redirected to the first situation, where another shaft was begun. This was in search for the "lower rock," so called, or the "slate rock" supposed to overlie the "coal." Here they went through the same materials, shutting off the water in the five foot sand-bed, and 60 feet of fine clay, when water rose so copiously from the second sand-bed (No. 6 of the first section given) as to compel a cessation of the work. In this shaft were found small pieces of the same coal, all the way. These pieces had sharp corners and fresh surfaces. The total depth here was 106 feet, and the water seems to have been impregnated with the same gas as that which rose in the drill at the point three-fourths of a mile distant. Such water is also found in the well at the hotel in Freeborn. With sugar of lead it does not present the reactions for sulphuretted hydrogen, and the gas is presumed to be carburetted hydrogen.

This account of explorations for coal is but a repetition of what has taken place in numerous instances in Minnesota. The Cretaceous lignites have deceived a great many, and

considerable exspense has been needlessly incurred in fruitless search for good coal. In the early discovery of these lignites some exploration and experimentation within the limits of the state were justifiable, but after the tests that have already been made it can pretty confidently be stated that *these lignites are at present of no known economical value.* This, not in ignorance of the fact that they will burn, or that they contain, in some porportion, all the valuable ingredients that characterize coal and carbonaceous shales, but in the light of the competing prices of other fuels, the cost of mining them, and the comparative inferiority of the lignites themselves. If they were situated in Greenland they would probably be pretty thoroughly explored, and extensively mined, and even there they would have a powerful competitor in the oil there in use.*

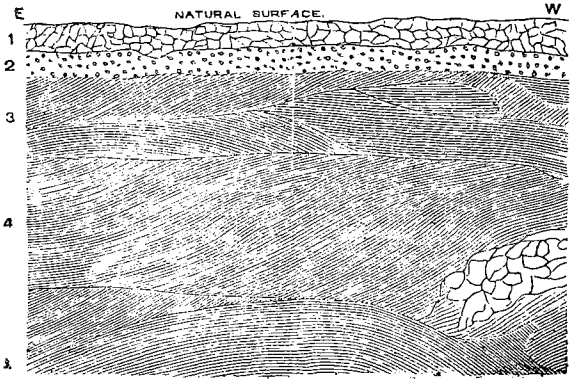
The drift.

This deposit covers the entire county and conceals the rock from sight. It consists of the usual ingredients, but varies with the general character of the surface. In rolling tracts it is very stony and has much more gravel. In flat tracts it is clayey. It everywhere contains a great many boulders, and these are shown abundantly along the beaches of the numerous lakes of the county. The frequency of limestone boulders, and their significance, have already been mentioned. Thousands of bushels of lime have been made from such loose boulder masses, mainly gathered about the shores of the lakes.

In general the drift in Freeborn county consists of a glacier hardpan, or unmodified drift. Yet in some places the upper portion is of gravel and sand that show all the effects of running water in violent currents. The beds here are oblique, and subject to sudden transitions from one material to another. At Albert Lea the following section was observed. It occurs just west of the center of town. It covers eight feet perpendicular, and eight feet E. and W.

*See the second annual report, pp. 187 and 201.

Section in the drift at Albert Lea.



Explanations.

1. Earth and soil, gravelly below..... 20 inches.
2. Gravel, unstratified, with considerable limestone..... 6 inches.
3. Stratified gravel..... 18 inches.
4. Regular strata of coarse gravel..... 2 feet.
5. Unstratified.....
6. Fine sand, seen..... 2 feet.

In a gravel bank at Albert Lea, according to Mr. William Morin, the jawbone of a mastodon was found, a number of years ago. It was sent to St. Paul, and is supposed to be preserved.

The average thickness of the drift in Freeborn county would not vary much probably from 100 feet.

In the survey of the county considerable attention was paid to the phenomena of common wells, with a view to learn the nature and thickness of this deposit, and the following list is the result of notes made :

Wells of Freeborn county.

Good water is generally found throughout the county, in the drift, at depths less than 80 feet; but some deep wells that occur within the Cretaceous belt, in the western part of the county, are spoiled by carburetted hydrogen. This must rise from carbonaceous shales in the Cretaceous, and indicates the extent of that formation. Much of the information contained in the following tabulated list of wells was obtained by W. A. Higgins, well borer, of Albert Lea:

Owner's Name.	Location.	Depth. Feet.	Kind of Water.	Remarks.
W. P. Sargent.....	Sec. 29, Albert Lea.	28	Good.	One-half bu. of coal at 26 ft.
Geo. Stevens.....	Freeborn.	47	Carburetted	Pieces of coal in blue clay,
T. A. Southwick...	"	46	Soft.	44 ft. of water. [26 ft. water
Ezra Stearns.....	½ m. w. of Freeb'n.	30	Good.	Found pieces of coal.
Ezra Stearns.....	" "	42	"	" " "
James Hanson.....	1 m. nw. of Freeb'n.	50	Carburetted	" " "
F. D. Drake.....	Sec. 13, Freeborn.	90	"	Water stands 5ft. from top.
O. U. Wescott.....	Byron, Waseca.	94	Soft.	[stones and gravel.
L. C. Taylor.....	6 ms. nw. Freeborn.	96	Good.	Artesian; at first bringing
Geo. Snyder, Jr....	2 ms. nw. Freeborn.	61	Carburetted	[clay
A. M. Trigg.....	Alden.	37	"	Found pieces of coal in
H. M. Foot.....	"	50	Good.	" " " "
John Melender.....	"	50	"	" " " "
L. C. Taylor	6 ms. nw. Freeborn.	96	Carburetted	Artesian.
Wm. Comstock.....	2 ms ne. Alden.	48	"	Nearly artesian.
Chas. Ayers.....	Nw. cor. Freeborn.	125		Bore for coal.
John Ayers.....	Trenton.	142		" " " lost tools.
T. A. Southwick...	Freeborn.	35	Carburetted	Blue clay, water in sand &
J. F. Jones.....	Geneva.	20	Good.	Water in q'ksand. [gravel.
Nelson Kengsley..	"	12	Soft.	Water in quicksand.
John Farrell.....	"	12	"	" " "
A. Chamberlain...	"	12	"	" " "
D. G. Parker.....	Albert Lea.	72	Good.	Struck gravel below the
Dr. C. W. Ballard..	"	38	"	In gravel. [blue clay.
James Barker.....	"	52	"	Small bed of gravel in blue
C. W. Levins.....	"	25	"	In gravel. [clay.
H. Rowell	"	72	"	In gravel below blue clay.
W. W. Cargill	"	85	Not good.	Struck black clay, no sticks nor grit. [clay.
Chas. Ostrom.....	"	30	Good.	In very fine blue sandy
Lewis Gaul.....	"	28	"	"Yellow clay" all the way.
H. Rowell.....	"	72	"	Yel. & blue cly. then gravel
Col. S. A. Hatch...	Sec. 4, Albert Lea.	42	"	Gravel and sand, water in
Ole Knutson.....	Albert Lea.	34	"	" " " [quicksand.
W. W. Cargill.....	Sec. 28, Albert Lea.	28	"	Water in gravel. [on rock.
Geo. Topon.....	Sec 29, "	65	No water.	Grav'ly cl'y. fine sandy cly
And. Palmer.....	Sec. 29, "	28	Good.	Water in green sand.
Dr. A. C. Wedge...	Sec. 8, "	28	"	" " "
W. C. Lincoln.....	Albert Lea.	32	"	Gravel and sand, then q'k-
Frank Hall.....	"	65	"	" " " [sand.
Town well.....	Alden.	44	"	In gravel.
A. W Johnson.....	Albert Lea.	80	Not good.	Drift clay, water in gravel
Rev. G. W Prescott		80	"	"Tastes like kerosene."
Town well.....	Twin Lakes.	75	"	Clay only.
	Alden.	40	"	
A. Palmer, Jr.....	Sec. 29. Albert Lea.	30	"	Lump of coal at 27 feet.

In some wells at Albert Lea a muck is struck, and such wells afford a water that is unfit for use. This muck is reported to contain sticks, and is about 38 or 40 feet below the surface. It may indicate a former bed of the river, or an interglacial marsh, as Mr. James Geikie has explained in Scotland. (See "The Great Ice-Age.") It is by some called *slush*, and seems not to uniformly hold sticks and leaves, but to be rather a fine sand of a dark color. The well-diggers call it quicksand. This indicates that it is either a bed of Cretaceous black clay, arenaceous, or Cretaceous débris. Dr. Wedge, of Albert Lea, thinks the site of the city was once covered by a lake, and that this *slush* was its sediment; and that the overlying gravel, which is about 38 feet thick, has since been thrown on to it by a later force, perhaps by currents. There is no doubt that the overlying

gravel was thus deposited, those currents being derived from the ice of a retiring glacier.

Wells at Geneva are generally not over 20 feet in depth They also pass through a gravel that overlies a quicksand. This village it situated with reference to Geneva lake as Albert Lea is with reference to Albert Lea lake, both being at the northern extremities of those lakes. The phenomena of wells at the two places are noticeably similar, and in the same way different from the usual phenomena of wells throughout the county.

At Albert Lea.

Gravel, about 30 feet.
Quicksand, with water, sometimes black and mucky.

At Geneva.

Gravel, 12 to 15 feet.
Quicksand, with water.

It would seem that the history of the drift at Albert Lea was repeated at Geneva. These villages being both situated at the northern end of lake basins, are probably located where preglacial lakes existed. On all sides, both about Albert Lea and Geneva, the usual drift clay, hard and blue, is met in wells, and has a thickness of about 100 feet.

Material resources.

In addition to the soil, Freeborn county has very little to depend on as a source of material prosperity. As already stated, there is not a single exposure of the bed-rock in the county. All building stone and quicklime have to be imported. The former comes by the Southern Minnesota R. R. from Lanesboro and Fountain, in Fillmore county, though it is very likely that the Shakopee stone from Mankato will also soon be introduced. The latter comes from Iowa, largely, (Mason City and Mitchell), and from the kilns at Mankato and Shakopee. Some building stone is also introduced into the eastern part of the county from the Cretaceous quarries at Austin.

Lime.—At Twin Lake three or four thousand bushels of lime have been burned by Mr. Carter from boulders picked up round the lake shores. This lime sold for 75 cents per bushel. It was a very fine lime, and purely white. The construction

of the railroad put a stop to his profits, as the Shakopee lime could then be introduced and sold cheaper. The boulders burned were almost entirely of the same kind as those that are so numerous in McLeod county. They are fine, close-grained, nearly white, on old weathered surfaces, and of a dirty cream color on the fractured surfaces. They very rarely show a little granular or rougher texture, like a magnesian limestone, though this grain is intermixed with the closer grain. They hold but few fossils. There are a few impressions of shells, and by some effort a globular mass of a coarse favositoid coral was obtained.

Besides the above, which are distuinguished as "white limestone," there are also a few bluish-green limestone boulders. One of these, which now lies near Twin Lake, is about 7 feet long, by 5 or 6 feet broad, its thickness being at least $2\frac{1}{2}$ feet. It has been blasted into smaller pieces for making quicklime, but nearly all of it yet lies in its old bed, the fragments being too large to be moved. This stone is also very close grained. It is heavier than the other and more evidently crystalline. It holds small particles of pyrites. It is not porous, nor apparently bedded. On its outer surface it looks like a weathered diorite, and it would be taken, at a glance, for a boulder of that kind. It is said to make a very fine lime. Several hundred bushels of lime were formerly burned at Geneva.

Brick.—At Albert Lea the following persons make brick: George Broughton, Wm. Cook, (G. C. Dillingham,) Hubbell Manly, (one and a half miles N. of Albert Lea; has made none in four years.) These all make what is known as "slop brick," i. e., they handle and dry them after mixing in water, without the use of sand. The latter method (with sand) is much quicker and pleasanter, but in the use of the brick there is not much choice between the methods. At Boughton's the brick are red. The clay used, which is about five feet below the surface, is fine and of a yellowish ashy color. It is underlain by gravel. The clay itself locally passes into a sand that looks like "the bluff." At other places it is a common, fine clay-loam, with a few gravel-stones. There is but little deleterious to the brick in the clay, although some of the brick are, on fractured surfaces, somewhat spotted with poor mixing, and with masses of what appear like concretions. The clay itself is apparently massive, but it is really indistinctly bedded, rarely showing a horizontal or oblique, thin layer of yellow sand. Mr. Boughton sells brick at ten or twelve dollars per thousand.

His yard has only been running the past summer, but has turned out 200,000. They have been used in Albert Lea, and by the farmers around. Oak wood costs from five to six dollars per cord.

The yard of Mr. Cook also furnishes red brick. He uses the same stratum of fine clay overlain by the same yellowish sandy clay or loam. The clay here shows to better advantage and is plainly bedded. It contains sticks, the largest observed being a little over half an inch in diameter. These sticks are plainly endogenous in cellular structure, but have a bark. They are not oxydized so as to be brittle, but are flexible still, with small branches like rootlets hanging to them. It is uncertain whether they belong to the deposit, or are the roots of vegetation that grew on the surface since the drift. There are no boulders of any size in the drift just here; but a few granitoid gravel-stones. The aspect generally indicates that this clay has a local character largely, but no outcropping beds can be found in the neighborhood. Mr. Cook has made this year (1874) 250,000 brick. The yard has been running five years. Brick here sell for $1.30 per hundred as they come from the kiln, or $10.25 per thousand. Hard brick from the arch sell at $1.50 per hundred. The brick here seem to show a little more lime, but they are well made and well burned.

Brick were formerly made at Geneva, and at a point about 2½ miles east of that place. At Geneva the clay was taken from the bank of Allen creek, about 18 inches below the surface. It was a drift clay, with small pebbles. That used 2½ miles east of Geneva was of the same kind. In both places sand had to be mixed with the clay. About Geneva sand is abundant, taken from the gravel and sand knolls, and from the banks of the creek.

Peat.—In Freeborn county there is an abundance of peat. The most of the marshes, of which some are large, are peat-bearing. In this respect the county differs very remarkably from those in the western portion of the same tier of counties which were specially examined for peat, in the season of 1873, and which, being entirely destitute of native trees, are most in need of peat for domestic fuel.

The peat of the county is generally formed entirely of herbaceous plants, though the marshes are often in the midst of oak-openings. The peat-moss constitutes by far the larger portion. There is no observed difference in peat-producing qualities between the marshes of the prairie districts and those of the more rolling woodland tracts of the country.

At Alden village, in the midst of the open prairie, the peat of a large marsh rose to the surface and floated, when, for certain purposes, the marsh was flooded. The water now stands ten feet deep below the floating peat, which is about three feet thick.

At Freeborn peat is now being taken out on John Scovill's land. Here it is eight feet thick, two rods from the edge, and it is probably much thicker toward the center of the marsh. That below the surface of the water now standing in the drain is too pulpy to shovel out; and after being dipped out and dried on boards, it is cut into blocks and hauled to town. That above the water is more fibrous, and can be taken out with a spade in convenient blocks. Yet the level of the water varies, and that datum is not constant. It appears as if there was here a stratum of more fibrous peat that separates from the lower, about 20 inches thick, and floats above it at certain times. In the peat at this place a sound elk horn was taken out at the depth of 6 feet.

There is a large peat marsh in sec. 11, Hayward, owned by non-residents.

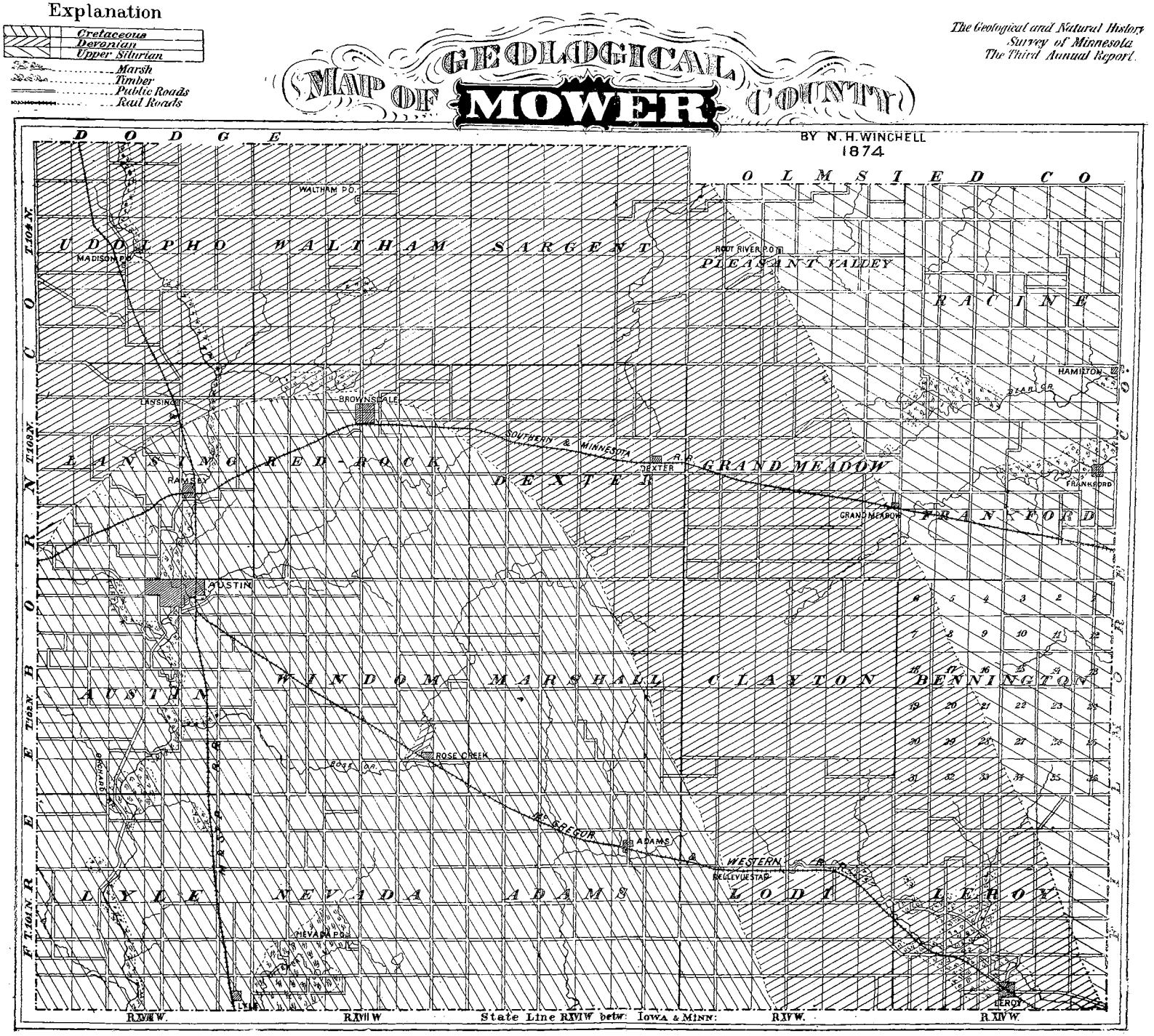
REPORT ON THE GEOLOGY OF MOWER COUNTY.

Situation and area.

This county borders on the state of Iowa. It is bounded west by Freeborn county, north by Dodge and Olmsted, and east by Fillmore. It has Mitchell county on the south, in Iowa. Its shape is very nearly that of a rectangle, (5 towns east and west, and 4 towns north and south), but it lacks the northern line of sections in the northeast, across two towns. These sections were set off to Olmsted county when Austin was made the county seat. It has, therefore, about 708 square miles, or more exactly, 455,204.81 acres, according to the records of the State land office.

Natural drainage.

The Cedar river crosses this county from north to south, through the western line of towns, its point of exit being exactly south from its point of entrance. Its chief tributaries from the east are Dobbin's creek, Rose creek, Otter creek and Robert's creek. From the west it receives Orchard creek and Turtle creek. Thus the whole of the western half of the county is drained into the Mississippi, through Iowa. The southeastern portion, also, is drained toward the south, through the sources of the Little Cedar, the Wapsipinicon and the Upper Iowa rivers. The northeastern portion of the county is drained by the head waters of the Root river toward the north and east. This river flows eastward through Fillmore and Houston counties, into the Mississippi near La Crosse. The divide between streams running north and those running south crosses Mower county from SE. to NW. nearly through the center, and


Explanation
Cretaceous
Devonian
Upper Silurian
Marsh
Timber
Public Roads
Rail Roads
GEOLOGICAL MAP OF MOWER COUNTY
The Geological and Natural History Survey of Minnesota The Third Annual Report.
BY N. H. WINCHELL 1874
DODGE
OLMSTED CO
FILLMORE CO
WALTHAM P.O.
MADISON P.O.
UDOLPHO
WALTHAM
SARGENT
ROOT RIVER P.O.
PLEASANT VALLEY
RACINE
HAMILTON
BEAR CR.
LANSING
BROWNSDALE
SOUTHERN & MINNESOTA R.R.
DEXTER
LANSING
RED ROCK
DEXTER
GRAND MEADOW
RAMSEY
FRANKFORD
GRAND MEADOW
AUSTIN
WINDOM
MARSHALL
CLAYTON
BENNINGTON
AUSTIN
ROSE CREEK
ROSE CR.
R.R. GREGOR
ADAMS
WESTERN R.R.
BELLEVUE STAR
LYLE
NEVADA
ADAMS
LODI
LEROY
NEVADA P.O.
LEROY
T.104 N.
T.103 N.
T.102 N.
T.101 N.
R.XVI W.
R.XVII W.
State Line R.XVIII W. betw. Iowa & Minn.
R.XIV W.
R.XIV W.

includes some of the highest land in that portion of the state. The highest point in the county, on the Southern Minnesota R. R., is in sec. 13, T. 103, R. 16 W., and that is 738 feet above Mississippi at Grand Crossing, or 1352 feet above tide water.

These streams are all small, and some of them become nearly dry during the summer. Some of them furnish water power at a number of places. This has been improved on the Upper Iowa at Le Roy, and on the Cedar at Ramsey, Austin, and at several places below Austin, in the construction of flouring mills.

Surface features.

The county is distinctively one of prairie, yet has a considerable timber along the streams. This is particularly the case along the Upper Iowa in the southeastern part of the county, along the eastern tributaries of the Root in Frankford, and along the Cedar crossing the whole width of the county. There is is also an important tract of timber in Nevada township. The highest portions of the county are entirely destitute of trees. They consist of a wide expanse of undulating prairie. The southern towns of Lyle, Nevada and Adams may be characterized as flat. The same is true of the most of the supposed Cretaceous area. The summit of the principal NE. and SE. watershed is formed by the Lower Devonian, with the strike of which it substantially corresponds. Toward the east from this summit the valleys of the streams running in that direction have been deeply cut out, yet not revealing any rock. They are wide, and their natural scenery is often very fine, as the view of the low expanse, wooded more or less, first appears before the traveler. The western portion of the county is considera bly below the central and eastern. This is owing to the valley of the Cedar, the effect of which is felt over a wide belt, in depressing the general level. The following points of elevation above the ocean are derived from the profile of the Southern Minnesota R. R. by O. D. Brown, engineer:

Grand Meadow, (sec. 14, T. 103, R. 15)	1325 feet.
Sec. 13, T. 103, R. 16	1402 feet.
Ramsey, (grade of the Milwaukee & St. Paul R. R.)	1233 feet.*
Hayward	1240 feet.

*In the report for 1872 this crossing is given at 593 feet above the Mississippi river at La Crosse, the datum line of the S. M. R. R. on the authority of chief engineer H. W. Holley. Adding 614 feet makes 1207 feet for its hight above the ocean.

The following were derived from the Milwauke & St. Paul R. R., through ——— Angst, chief engineer:

Madison	1127 feet.
Ramsey	1093 feet.
Lyle	1075 feet.

The following minutes, touching the surface features, are based on an examination of the township plats of the government surveys, on record in the land office. The county was surveyed in 1853. There is not a lake of any importance in the county, and but few marshes.

Le Roy. (101,14)—East half.

The Upper Iowa river crosses diagonally the southern portion of this town, and introduces a belt of undulating and more or less timbered land, about two miles in width. Some of the thickets are very dense, but generally the timber is scattering. The remainder of the town is prairie, with a large slough covering portions of secs. 5 and 8. There is a "second bottoms" noted in sec. 18, and John Priest's house in sec. 36. Magnetic variation 9° 12′ to 10°.

Bennington. (102,14.)

In the center of this town is one of the sources of the Root river, a Y-shaped slough, with an outlet toward the east. The whole town is prairie. Mag. var. 8° 15′ to 12° 30′, the former in sec. 6, the latter in sec. 3.

Frankford. (103,14.)

This town is about equally divided between prairie and openings, the former being the SW. portion and the latter the NE. portion. The timber is generally small, and often scattering. There is a marsh in sec. 9, and settlement was begun in NE. corner of sec. 1. Mr. L. Patchin, of Frankford, was one of the first settlers. Mag. var. 7° (in sec. 7) to 12° 15′ (in sec. 36.)

Racine. (104,14.)

There is a belt of openings, and undulating land along the southern line of this town, caused by the tributaries of the Root river, and other areas of sparse timber and brush in

secs. 10, 8 and 7, but the greater portion is of prairie. It contains but little marsh. Var. 6° 57′ to 11° 15′. Mr. J. McQuillan was the earliest settler in Racine. The same year Mr. L. Patching settled at Frankford and laid out the village.

Le Roy. (101,15)—West half.

This town consists almost entirely of prairie. The Upper Iowa river in the eastern portion introduces some diversity of surface, and some timber. There is also a small area of similar land in the NW. corner of the town. The headwaters of the Wapsipinicon are in sec. 32, and drain a long, narrow marsh, that extends two miles further north. The most of this town is prairie land. Mag. var. 8° 34′ to 9° 30′.

Clayton. (102,15)

This is a high prairie town, the drainage from it being to the SW. SE., and NE. Mag. var. 7° 39′ to 9° 7′.

Grand Meadow. (103,15.)

This township is all prairie. There is a slough with some standing water in secs. 17 and 20. Several of the high tributaries of Root river drain the eastern portion, introducing but little diversity of surface. Mag. var. 7° 35. to 8° 25′.

Pleasant Valley. (104,15.)

Except very small areas in the NE. and NW. corners of this town, it is entirely taken up with excellent prairie land. Those exceptions are small tracts of undulating and brushy, or sparsely timbered land, along the tributaries of the north fork of Root river. Var. 7° 50′ to 8° 55′.

Adams. (101,16.)

Through the central and northeastern portions of this town run the headwaters of one of the tributaries of the Cedar river, causing a belt of diversified country, widening to the north, and spreading into the northeastern part of the town. On the east and west of this belt is prairie land. Mag. var. 8° 43′ to 10° 5′.

In the northwestern portion of this town Rose creek introduces the usual variety of surface attending drainage valleys. Other areas of the same are in secs. 34 and 36. The rest is prairie. Mag. var. 7° 53′ to 9° 18′.

Dexter. (103,16.)

The southern part of this town is diversified by Rose creek, otherwise it is a prairie with drainage to N. and W. Var. 7° 25′ to 8° 30′.

Sargent. (104,16.)

This is of prairie, except in the eastern portion, where the valley of one of the upper tributaries of Root river causes an undulating belt with some timber. This belt runs NE., and is about a mile wide. Var. 7° 47′ to 8° 55′.

Nevada. (101,17.)

This town is mainly prairie, perhaps one-fifth of the whole area, situated in the southweastern quarter being openings and more undulating. Var. 7° 32′ to 9° 45′.

Wimdon. (102,17.)

The southern and central portions of this town are prairie —a wide strip along the west side, and a narrow one along the eastern, being more wooded. Rose creek crosses it from NE. to SW. It contains no lakes nor marshes. Var. 7° 24′ to 10° 6′.

Redrock. (103,17.)

The eastern half of this town is prairie. the western half openings, with small timber and brush. Mag. var. 7° 9′ to 8° 59′.

Waltham. (104,17.)

This town is mainly prairie, the only exception being about the streams in the SW. quarter. Mag. var. 7° 35′ to 8° 35′.

Lyle. (101,18.)

This township, being crossed by the Cedar, enjoys all the variety of soil and surface, as well as the timber which uniformly accompany the principal drainage courses. A belt of timber along the east side of the Cedar crosses the center of the town from north to south about a mile in width. The prairie on the west side runs to the very river. A wet meadow, or slough, occurs in sections 8 and 17, and another in sec. 2. Mag. var. 6° 57′ to 9° 54′.

Austin. (102,18.)

The western half of this town is prairie reaching up to the river. The eastern half is more wooded and broken. There is also a patch of prairie in the SE. corner south of Rose creek. Dobbin and Nichols were early settlers in the SE. corner. According to Mr. Patchin, of Frankford, Leveridge, was the earliest settler at Austin. Mag. var. 6° 57′ to 9° 42′.

Lansing. (103,18.)

There is a small area of prairie in the northern part of this town, but the most of it when surveyed was taken up with openings with scattered trees and brush. In the SW. quarter of the town is a long marsh drained into the Cedar. It is about three miles in length and a quarter of a mile wide running SE. Mag. var. 7° 9′ to 8° 40′.

Udolpho. (104,18.)

A belt of undulating, and more or less timbered, land crosses this town from N. to S. accompanying the east shore of the Cedar river. It is about two miles in width, increasing to four miles in the north. A small area of similar land is found covering portions of sections 30, 31 and 32. An important marsh also occurs in sections 27 and 34. Var. 7° 35′ to 9° 26′.

Soil and timber.

The soil of Mower county is everywhere dependent on the nature of the drift. The underlying rock has only affected it so far as it may have mingled with the general mass. It

is hence primarily a gravelly clay, that being the character of the subsoil throughout the county. This gravelly clay, however, is not now prominently displayed as the immediate soil of the surface. Indeed the farmer in plowing rarely penetrates to it. It lies below a rich loam usually, at depths varying from zero to two or three feet, or even more. The surface itself, which has resulted from it through the agency of the forces of the atmosphere and of vegetation, is of a dark color, and in general may be designated a clayey loam, or a sandy loam, depending on the nature and completeness of the local drainage. In low grounds this loam is thick and of a dark color. It is also apt to be more clayey in low ground than it is on the hillsides or slopes adjoining; and on high hills or steep slopes it is thin or wanting, the wash of the surface having carried it into the valleys. Along streams it often consists of an arenaceous loam, variously mingled with the detritus of the flood plain.

The soil of the county is everywhere characterized by the strength and fertility that the drift soils of the northwest are noted for. They are the most reliable soils for all the purposes of the farmer that are known. The states that are regularly and deeply buried in drift deposits are known as the best farming states of the Union. Certain rock-soils, endowed with unusual special qualities, may excel in the production of certain crops, especially in favorable seasons, but for general tillage they cannot compete with the homogeneous drift soils, through which are disseminated the good qualities of the various rocks concerned in their production, in the proportion that make stability and diversity equally certain.

In the examination of the county the native varieties of trees and shrubs were noted, and the following list comprises the species that were seen. In respect to the trees it is probably nearly complete for the county, but there are, doubtless, other species of shrubs:

Trees and shrubs of Mower county.

Burr oak. Quercus marcrocarpa *Michx.*
Red oak. Quercus rubra *L.* (Not fully identified.)
Aspen. Populus tremuloides *Michx.*
American elm. Ulmus americana (*Pl. Clayt.*) *Wild.*
Different species of willow. Salix.
Hazelnut. Corylus americana *Walt.*
Sumac. Rhus glabra *L.*
Ironwood. Ostrya virginica *Wild.*
Bass. Tilia americana *L.*

Elder. Sambucus canadensis *L.*
Wolfberry. Symphoricarpus occidentalis *R. Br.*
Prickly gooseberry. Ribes cynosbati *L.*
Cornel. Cornus (sp. ?).
American crab. Pyrus coronaria *L.*
Red osier dogwood. Cornus stolonifera *Michx.*
Alder. Alnus incana *Willd.*
Cottonwood. Populus monilifera *Ait.*
Thornapple. Crataegus coccinea.
Wild plum. Prunus americana *Marsh.*
Black cherry. Prunus scrotina *Ehr.*
Frost grape. Vitis cordifolia *Michx.*
Bittersweet. Celastrus scandens *L.*
Black currant. Ribes floridum *L.*
Wild rose. Rosa blanda *Ait.*
Cockspur thorn. Crataegus crus-galli *L.*
White ash. Fraximus americana *L.*
Shag-bark hickory. Carya alba *Nutt.*
[At Lansing, and in the valley of the Cedar, one foot in diameter.]
Sugar maple. Acer saccharinum *Wang.*
Bitternut. Carya amara *Nutt.*
Butternut. Juglans cinerea *L.*
White pine. Pinus strobus *L.*
[Along the rocky banks of the streams in the eastern part of the county.]
Slippery elm. Ulmus fulva *Michx.*
Black ash. Fraxinus sambucifolia *Lam.*
High bush cranberry. Viburnum opulus *L.*
High blackberry. Rubus villosus *Ait.*
Cedar. Juniperus virginiana *L.*

The geological structure.

Of the older rocks the lower portion of the Devonian and the upper portion of the Silurian are found within the county dipping towards the southwest. The western portion of the county is known to be immediately underlain by the lower Cretaceous, without ascertainable eastern limits. The accompanying geological map of the county exhibits the areas of these formations as nearly as can be judged by the data known. The rock is nearly every where hid by the drift and for that reason the actual positions of the boundaries are unknown. It is quite possible, indeed probable, that the Cretaceous area extends further east, with a broken and very tortuous eastern boundary. It occurs in counties further east. In regard to the separation between the limestones of the lower Devonian and the Upper Silurian, none has yet been discovered. It is simply known that a vast limestone formation, the upper part of which lies under Freeborn county next on the west, extends also under Mower, and appears conspicuously along the banks of the streams in the eastern portion. No characteristic fossils have yet

been seen in it in Mower county, but those that characterize the Hamilton were seen in it near Northwood in Iowa. The limestone seen at Le Roy is lithologically different from that which occurs at Frankford and resembles the Hamilton seen at Northwood. While lithological distinctions are not reliable always, especially after long intervals, yet at present this is the only reason known, so far as Mower county is concerned for separating that at Frankford from that at Le Roy. In Ohio and Illinois there is an arenaceous formation (the Oriskany) between the Devonian limestones and the Silurian, and it distinctly marks that horizon. While in the lower Devonian some arenaceous layers have been observed in Iowa, the Oriskany has not been identified there, and probably it cannot be depended on in Minnesota to mark the separation between the Upper Silurian and the Devonian. In the absence of good exposures of these limestones in the county, it is only possible to lay down approximately the boundary line between them, and that is all that has been attempted on the accompanying map.

The Cretaceous.

The principal exposures of the Cretaceous are found in the valley of the Cedar, at Austin, and from there to the state line. The quarry of Simon Anderson, at Austin, is in the left bank of the Cedar, and exposes about 20 feet of the bedding. Much of the stone is broken and disturbed, and lies in fine clay which seems to have been jammed into all the cracks and other openings in the rock. The beds here show sudden, broken-down places, in which this clay is deposited instead, the rock being wanting for three or four feet horizontally. The stone is much more entire, and uniform in all its characters at greater depths, some slabs five and six feet long, by three feet wide, and three or four inches thick being taken out. These have a very even, fine grain, and a handsome blue color. This stone is in its natural color, light blue, and that color shows on most of the quarried blocks about the heart of the bedding; and on deep quarrying it would doubtless show only a blue color. Yet the stone seen about the city is very generally of a buff color, to the depth of half an inch to three inches, depending on the amount of weathering and oxydation. The thinner beds are altogether changed to that color. The presence of occasional concretionary iron and mud balls causes a rusty stain of a yellow color over the surface of many of the slabs.

These concretionary balls fall out, or dissolve out, when in the water, and leave cavities which become larger still. Besides these, which are not common in the compact portion of the stone, but are oftenest seen among its thin beds, there are also cavities disclosed by the fracture of the homogeneous thick beds. These are sometimes perfectly empty, but often contain loose, friable matter, easily picked out, but not differing in color or grain from the mass of the rock. At other times such cavities, revealed on the fracture of the stone are lined with a perfect coating of drusy crystals which are white, and as hard as quartz, though sometimes covered with iron-rust, so as to present a red or black exterior. The texture of the stone itself is usually close, and the grain is homogeneous. Some large slabs and blocks are sawn for bases to tombstones, and worked down to a very smooth surface. It is more safely sawn to any desired dimension that cut or broken, since it fractures treacherously; yet it is not in the least crystalline. Its aspect at a distance is that of a fine-grained sandstone; yet it contains no apparent grit. It is so soft that it can be cut without difficulty, appearing much like an unusually indurated blue shale, but it hardens in use and becomes a very enduring and useful material for building. It contains, but very sparingly, a few molluscous fossils, too much absorbed to be identified, though one has the general form of a *Gryphaea*. This description of the stone applies equally well for the stone taken out at other quarries further down the valley, as mentioned below.

In the vicinity of Mr. Alderson's quarry, perhaps fifty rods distant, and about 14 feet higher, this stone was struck in making an excavation for the erection of a brewery. It here rose within two or three feet of the surface. The beds were thin, broken, and of a buff color. Enough stone was here obtained, in the excavation of a small vault, for the masonry appertaining to the brewery. The rock was here overlain by the following section of clays.

No. 1.	Black sandy loam and soil.....	2 to 4 feet.
No. 2.	Band of red and variegated compact clay.....	6 in. to 4 feet.
No. 3.	Yellow ocherous band of clay.	6 in. to 4 feet.

The superposition of these bands of clay is not so regular as indicated by the foregoing section : occasionally No. 3 is broken through or is wanting, and No. 2 lies on the rock, or passes down into its crevices. Yet No. 3 is generally the first over the rock. They vary in thickness and swell out in shapeless masses of hard clay. Such hard masses are

seen sometimes to embrace bits of angular earthy rock, much like ochre, varying in color from a dark, burnt-umber color to a lighter shade, even to buff, and appearing, when of a lighter color, much like the mass of No. 3. They can be scratched easily with a knife, and however black they may be they give a red hematite streak. When they are faded the streak also fades into a brown or yellowish brown like limonite. Intermingled very irregularly with No. 2 and sometimes also with No. 3 are masses of greenish clay which has in every other respect the same outward characters as No. 2. There are here also large crystalline, detached masses of apparently a silicious limestone which is very hard and close-grained. In some cases, however, this varies to a porus and nearly white limestone that appears to be very pure.*

At Austin angiospermous leaves were obtained from this stone in the digging of a well by Mr. L. G. Basford. After passing through soil and loam three or four feet, and clay about 20 feet, the rock was struck and penetrated by removing the upper layers, a thickness of about eight feet. Two species of fossil leaves were found in the layers thus entered. One appears like *Ficus primordialis* Hr., as figured in "*Les phyllites Cretacees du Nebraska par M. M. les prof. J. Capelini et O. Heer*," and the other is, according to Dr. J. S. Newberry, to whom a photographic copy was submitted, probably a species of *Sequoia*, a gymnosperm of the pine family known as "redwood."

At the mill of J. Gregson, about two miles below Austin, a great deal of stone has formerly been taken out, but now the quarries of that neighborhood are nearly all flooded by the water of the dam. The chief quarry was just above the present site of the mill and near the dam on the left side, though just below the dam the rock shows on both sides and has also been wrought. At this point Rosenberry and Miner have a quarry on the right bank, and a perpendicular bluff of the beds occurs near the roadside, below the mill on the left bank. The exposed section at Rosenberry and Miner's is as follows, in descending order:

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*In connection with this description of limestone masses, it is interesting to note the occurrence at St. Charles, Winona county, of hard siliceous limestone masses on the surface of the ground, appearing very much like those embraced in this clay.

The reader is also referred to the *Geological report on the exploration of the Black hills under Gen. G. A. Custer, 1874*, for further information on the distribution of foreign limestone masses in Dakota.

No 1.	Black loamy soil	7 to 8 feet
No. 2.	Loose fragments of the underlying beds and clay mixed	3 feet
No. 3.	Heavy stone like that described at Austin, clay filling the open planes and joints	10 to 12 feet
No. 4.	Rusty bituminous films	½ to 1 inch
	[On the authority of the owners of this quarry to this section may be added the following.]	
No. 5.	Limestone, filled with shells, blue, contains flint, makes lime, penetrated	2 feet

The bedding of No. 3 is here broken in a manner similar to that of Alderson's quarry at Austin. The corners and angles of the beds are replaced by clay and the color of the stone is changed from blue to buff or drab, to the depth of about two inches.

Some years ago the rock was worked by Dr. Barns, of Austin, about half a mile above Gregson's mill. This quarry is now almost entirely flooded by the dam. The abutments of the upper bridge, at Austin, came from this quarry, in part. Judge Ormanzo Allen owned a quarry still above Barns' that was also considerably flooded by the same means. The quarry most worked was just above the mill, owned by M. J. Woodson. It is now entirely under water. Stone is still taken out, however, all along, both above and below Gregson's. The beds at Gregson's show very nearly the same characters as at Austin. The descent of the stream is over about fourteen feet of rock, the layers of which are sometimes two feet or more in thickess, or massive, much like an indurated shale. In weathering, these thick beds are checked by planes running mainly horizontal, instead of perpendicular or diagonal. Although mainly horizontal these planes are apt to unite after a few feet, splitting up the heaviest beds into wedging, lenticular masses. Some parts are here plainly calcareous, affording traces of fossil remains that have the appearance of Brachiopoda. These portions are porous as if by the absorption of fossils.

Mr. M. J. Woodson now works a quarry about ¼ mile above Gregson's mill, some distance from the river, pumping by windmill the water out of a slough in which the beds are exposed. A small creek passes through here, and this slough seems to be an expansion of the valley, retarding the water. The rock is here entirely below the water, and is nearly all blue, and in that respect appears well.

At the mouth of Rose creek about the same thickness of the same kind of stone can be seen in the bed and banks of the creek. A fine exposure is owned by J. D. Wooodard in

the right bank of Rose creek near the crossing of the road from Austin to Officer's mill, perhaps a mile above its union with the Cedar. It is again seen above Officer's on the land of Col. Lewis, on the east bank

At W. H. Officer's mill, the left bank of the river shows about 20 feet of bedding. This is one mile below Rose creek. South of this mill rock of the same kind is seen at a number of places before reaching the state line. At two miles below Officer's it is quarried on R. B. Foster's land; and on Mrs. John Niles', three-fourths of a mile below Foster's, on the west side of the river. Just below the state line is Alderson's mill, where it is again exposed. At officer's, the water power is 8 feet. It is 13 feet at Gregson's and 10 feet at Austin. Between Austin and Lyle the country is apparently a perfectly level prairie, and is doubtless closely underlain with the same rock as at Austin.

Two miles east of Officer's mill a farmer struck the same rock in two separate wells on his farm, in one at the depth of three feet and in the other at eleven.

Dobbin's creek, which joins the Cedar at Austin from the NE., furnishes a water-power of 14 feet by dam, where a mill is erected. A quarry in the left bank of this creek shows the same rock as already described at Austin in the Cedar. The bluffs of the creek just below the mill are about 30 feet, and show about 20 feet of rock. The beds are in every place greatly broken, and in some cases displaced. The rock is parted into blocks of varying size, according to the thickness of the layers, the uppermost being finest. Throughout, the partings, and all the interstices are closely filled with a greenish clay, making the whole a close and almost impervious mass. It has very much the aspect of the Cretaceous on the Silurian, as described at Mankato, (see the second annual report) except that the small cracks and openings are here all densely filled with the clay. The clay also very rarely has any distinct bedding, but seems rather to have been jammed in to fill the vacancies. Besides the greenish clay which often varies in color to a red or a buff, there is also considerable white, clean sand, lodged in these cavities in the rock. This pertains to no particular horizon, and shows no definite arrangement. It is disposed everywhere, just like the clay, occurring from the top to the bottom of the bluff—though perhaps more abundant near the bottom.

These two deposits—the clay and the white sand—are doubtless the result of destructive forces upon other portions

of the Cretaceous. There is presumptive evidence, in their being here irregularly mingled with a series of beds that lie nearly *in situ*, that they are derived from some *overlying* members of the Cretaceous. That evidence would be more reliable if the general dip of the Cretaceous were toward the north or northwest, thus throwing the beds of the quarry deeper below the surface in those directions and rendering them less susceptible of such disruption as would expose the underlying members to the glacial forces. That is naturally the first inference on beholding the face of the bluff. On the contrary the actual dip of the Cretaceous, if it have any at all, would be in general toward the south or southwest at this place, and the lower members are thus brought nearer the surface and within the transporting agency of the glacial forces at points toward the north. Thus this clay and sand may have been brought, by the action of ice, in the glacial epoch, from the north or northwest and deposited on the top of an overlying rock, in the same manner as granitic boulders are brought from a granitic region toward the north and are spread by the agency of ice, over the Silurian or Devonian, or even over the Cretaceous, that overlie, by hundreds of feet, the granitic beds from which they are derived. This clay and sand, however, are so fragile that they would soon lose their identity in being carried by the mixing power of a glacier, and cannot have been far transported. Indeed the area over which the beds of the rock with which they are mingled are known to extend unbroken, without perceptible dip in any direction, is quite as great as they could be carried by glacial action and deposited in distinct and characteristic homogeneity. There is hence a strong probability that the rock from which they are derived occupies a higher geological horizon than that among the broken beds in which they appear. This white sand must be the same as that seen on the Blue Earth and its tributaries, and on the Waraju in Brown county (see the second annual report, pages 133 and 185). It there lies on the Lower Silurian unconformably. Here it seems to be underlain by an older member of the Cretaceous—the Austin rock. This indicates the earlier submergence of this portion of the state beneath the ocean of the Cretaceous age, and the approach of the Cretaceous ocean from the east or southeast. As to the relative ages of this dislodged clay and white sand, there is no way of deciding which is the older from any certain evidences in Mower county. But in Brown county there is a bluish-green clay that overlies the white sand.

This rock is also wrought on the right bank, just above the mill, showing here also the same features.

At Sargent's spring, SW. ¼ sec. 31, Redrock, there is apparently an exposure of this white sand below the level of the water of a little pool. This place is a local celebrity. Pure, soft water boils up over the area of about a square rod, and sometimes over double that area, and can be seen issuing from the ground, bringing with it clean, white sand. The bottom of the pool presents a beatiful appearance. The water is as clear as crystal, and the boiling points which appear by reason of the rising white sand, in the midst of the darker sediment, can be minutely inspected at a depth of five or six feet. Running a stick into the agitated sand, it soon strikes a sandrock which is doubtless the source of the boiling sand, and the same bed that furnished that at the quarry in Dobbin's creek.

On the SE. ¼ sec. 12, Windom, Mr. Thomas Smith has struck the Cretaceous in making explorations for coal. From Mr. Smith the following account of his efforts was obtained. His attention was first attracted by a "scum that stood on stagnant water" and by the "mud brought up on horses feet" in crossing the creek bottoms. Having chosen a locality along the bank of Rose creek which he judged suitably free from water, he began to drift into the bank of the creek following a bed of vegetable material that had the appearance of old peat, but which contained some coarse pieces of fibrous wood. The choice of this place was altogether accidental, the desire being to obtain a place free from water. There were no surface indications favoring coal at that point. He accidentally came upon the peat bed. At first the peat, of which Mr. Smith has preserved samples, and which consists entirely of comminuted vegetable fibre, was only half an inch thickness. In the coarse of the drift it gradually thickened at 70 feet, to 18 inches in thickness. This drift was nearly level, inclining a little for the sake of drainage. On the top of this peat, pieces of wood which were judged to be of pine and cedar, of which also Mr. Smith has pieces preserved, were found in abundance. One large piece was two feet long and ten inches in diameter, supposed to be pine. This drift was about 50 feet below the general surface and 6 or 7 feet above low water in Rose creek. Above it was a blue clay with gravel stones. Below it was also a dark blue clay with gravel stones. This peat seems to have been in a genuine ancient peat lake, filled or partly filled, on which

floated pieces of wood from the surrounding forest. The whole was buried again by glacial deposits fifty feet thick.*

This drift having been abandoned at 80 feet, a shaft was sunk twenty rods toward the SW. to the depth of 50 feet, meeting the same peat. This shaft passed through fifteen feet of sand, ten or twelve feet of yellow clay, and about 23 feet of gravelly blue clay. Then east of the drift 40 rods a shaft was sunk on lower ground, but not on the bottoms, though somewhat within the general valley. The section here was, as given by Mr. Smith:

No. 1.	Soil and gravel	5 feet
No. 2.	Gravelly blue clay	4 or 5 feet
No. 3.	Gravelly yellow clay	14 feet
No. 4.	Blue clay, not gravelly	9 feet
No. 5.	Brown, waxy clay, fine	6 inches
No. 6.	Rock with water, (Mr. Smith says a specimen of "blue slate" came from this level)	3 feet
No. 7.	A soft rock which furnished fine drillings that were taken for coal	4 feet

In this drill, the first 22 feet of which were a shaft, Mr. Smith next came upon a very hard rock, and as all his work was done by hand he did not succeed in entering this stratum, nor in getting a specimen.

At this point Mr. Smith made efforts to get help from the county commissioners but they declined. He next sank a shaft forty feet in depth, about twenty feet from the last, meeting about the same materials, except that here there was no "blue clay, not gravelly," and no "fine, waxy, brown clay." He struck the rock at the same depth. The bottom of the "gravelly yellow clay" here was hard "like brick," cemented by deposits from the water which came in from below immediately after penetrating through it. This was a shaft throughout. Here the work stopped.

On visiting the last shaft which was all dug, the rock struck is seen in fragments lying about. It is a fine sandstone now rusty brown with iron, but which on being taken out was at first of a bluish gray color, like the deeply cut Austin stone. This is somewhat coarser than that and more loosely grained, but in every other respect appears to be the same rock.

* This peat was again struck in a shaft twenty rods further SW. from the drift, and was there about a foot thick, and about the same depth below the surface. It was met in wells two and a half or three miles northwest, at thirty-five feet.

The Devonian.

The most westerly outcrop of these limestones within the county, is that on Mr. Andrew Robertson's land, sec. 26, Windom. The rock here seen is course and porous, but rather firm, and very slightly exposed. It occurs in the valley of a small tributary of Rose creek.

The quarries at Le Roy are owned by Joseph Brevier, Judson A. Palmer, Stephen Drowne, and the heirs of L. Johnson.

The quarry owned by the heirs of Johnson is about forty rods from the state line, in sec. 35, Le Roy. It is in a lightly timbered tract of country, accompanying the upper Iowa river, and about ten rods south of the river. The beds rise to within a foot or two of the surface, on the angle of the river bluff, though the bluffs of the river are not conspicuous, the depth of the valley being only about twelve or fifteen feet below the general level, and broad and basin-like. The foreign drift about is light, but some large boulders are scattered about. This stone is light colored (nearly white) hard and fine, exactly like the Devonian seen near Northwood, in Iowa, though in heavier beds than that. It would make a beautiful white marble. It is uniform in grain and texture, and not in the least porous. With the exception of one or two layers of an inch or two of green clay, the beds are all of this limestone, exposed twelve feet.

At Palmer's quarry the rock is overlain by six inches of soil, though a hundred rods from the river. These beds are all badly weathered so far as opened, and of the same general character as at Johnson's. No drift. Exposed three feet.

Mr. Palmer's other quarry is in the river bluff, and easy of access. The stone is the same as that already described, and has been burned near the quarry for quicklime. It forms a bluff, exposing about twenty feet.

Brevier's quarries, of which two are opened, are in the left bank of the Upper Iowa river, and show about the same beds as seen in the other quarries.

Drowne's quarry is also in the bank of the river, but shows only about six feet, though there is every opportunity for opening the beds to a greater depth. There is here a much more argillaceous and fissile bed than any seen in the other quarries. It is about eighteen inches thick. This layer, coming about midway in the quarried beds facilitates the working of the quarry, but is itself of no value. In

the débris thrown out, probably from this layer, a globular mass of *Cœnostroma* was obtained, which, taken with the lithological resemblance of the rock to that containing Hamilton fossils at Northwood, in Iowa, near the Minnesota state line, satisfactorly establishes the Devonian age of the whole of the rock at Le Roy.

Section 16, Le Roy, Mrs. Alice Plummer owns a newly opened quarry near the river.

There is an exposure of the limestone in the valley of the Upper Iowa, near the west line of the SE. ¼ of NW. ¼ of sec. 29, Le Roy. There is here a boiling spring coming out of the rock in the bed of the creek. The rock is also exposed just over the state line, in Iowa, on the Little Cedar, and more particularly at Staceyville, two miles south of the line.

The Silurian.

As already stated, the rock at Frankford is classed as Silurian on lithological evidence only. The quarries here, beginning with the highest up the creek (known as Dear creek) are owned in the following order: A. Bush has a quarry about four miles above Frankford; G. Fryer has a good quarry; E. W. Elder burns and sells lime at Frankford; L. Patchin's quarry is situated in the brow of a small valley tributary to Deer creek, and consists of beds that are much shattered and weathered, so as to afford irregular and small pieces, considerably used for lime. Exposed about seven feet. These beds overlie or are very near the tops of the beds in the next—that of Mr. J. Hawkins. This is in the bluff of Deer creek, and supplied the heavy stone placed in the abutments of the highway bridge at Frankford. The exposure here is about twenty feet. The layers are three feet and more in thickness, and project over the water. This is a characteristic exposure. The rock is different from that at Le Roy. It is of about the same color, somewhat darker, vesicular and porous. It is firm, has abundant calcite, and some chert. While it is plainly fossiliferous, no fossils demonstrating its age are obtainable. J. C. Easton also owns a quarry at Frankford, back from the creek, on the open prairie. Other outcrops occur favorable for quarrying. In the scarcity of fuel, but little lime is made at Frankford. Much more is burnt at Spring Valley.

A stone quarry is opened two miles northwest of Grand Meadow, on Bear creek, owned by Mr. Coin. Another is 2½ miles east of Coin's, owned by Mr. I. O. Huffdaw.

The drift.

In Mower county no diminution of the drift was noticed. It consists of the usual hard-pan clay. This clay shows a light color for the first 10 or 15 feet, and below that depth it is apt to be blue. Gravelstones and boulders are disseminated through it. Some of the boulders are very large and consist of granite. Some very large granite boulders occur near Rose creek village, lying on the surface, and some are near Adams. There are some also in the valley between Adams and Le Roy. Near Mr. Alderson's quarry at Austin a granite boulder has been blasted and broken for building stone. It is at least 16 feet long by 12 feet wide. Its depth is unseen. Others were seen equally large in various parts of the county.

The most interesting development in respect to the drift in Mower county consists in the discovery of an ancient bed of peat by Mr. Smith in Windom. The reader is referred to the account of his operations for coal, already given, for the particulars of this discovery. This bed of peat seems to be of considerable extent, superficially. A similar deposit is struck in wells at Le Roy. Mr. J. D. Wilsey, on sec. 31, met it at 20 feet. Mr. Porter, who dug his well, describes the deposit there as largely made up of distinct woody fiber, among which he thought he recognized hemlock bark. Several other instances of striking this buried vegetation are reported in the neighborhood of Le Roy. The clay overlying the peat bed is described as a gravelly yellow clay.

In the state of Iowa an ancient peat has also been met with at a number of places. Dr. White describes it at Davenport, at Iowa city, and in Adair county (*Geology of Iowa*, 1870, Vol. 1, p. 119) and refers its origin there to marshes that accompanied the valleys of the rivers near which the peats occur, when those rivers spread wider, and flowed at higher levels. But in Mower county the peaty deposit is not confined to the valleys of streams, nor to the proximity of streams. Mower county is on one of the highest divides in the state of Minnesota, and from it flow the sources of streams toward the north, south, and east. Those streams are small and never could have flooded the extent of country in which this peat is found. The positive information now at hand in reference to this peat deposit in Mower county, does not warrant confident assertions as to its origin. From all accounts it appears to be embraced

between glacial deposits of gravelly clay, and it seems to mark a period of interglacial conditions where coniferous trees and peat mosses spread over the country. Peat mosses are not necessarily restricted to low, wet places. If the atmosphere be moist they will flourish on any surface, and an accumulation of good peat may take place on a bare, rocky mountain-side. There are extensive marshes now existing in northern Minnesota, mainly covered with ericaceous plants, with some cedars and tamaracks, that are forming immense peat deposits. With an increase in the amount of moisture of the air such peaty accumulations would spread over much higher levels. A return of glacial conditions would bury such marshes below the deposits that are known as drift.

At Le Roy Mr. Porter seems also to have discovered, just in the border of the village, an old valley, now filled with sand. His cistern was dug in the solid rock, which was met at seven feet. A well was bored fifteen feet distant toward the river, to the depth or 32 feet, in sand, without meeting any rock. Between this well and the river other wells have struck the rock at several places, and usualy at about twelve feet. On the prairie throughout the county wells get water generally within thirty feet.

Material resources.

With the exception of the central hight prairie portion of Mower county, it is tolorably well supplied with wood for common fuel. On the prairies referred to wood is costly. That portion of the county is thinly settled with farmers. Along the valleys of the streams in the eastern and western portions of the county, the first settlements took place, and in those valleys are found the most of the population at this time. The principal natural wealth of the county lies in its soil and its agricultural adaptations. The people are generally farmers. The growth of the county in all respects will be primarily dependent on, and co-ordinate with the settlement of the farming lands, and their profitable tillage. There is some water power in the county, as at Austin, and below Austin to the county line, and at Le Roy and Ramsey, and it is well improved in the erection of flouring mills. Mower county contains no peat, and cannot hope for coal. The rocks that underlie the county cannot be depended on for producing anything but building stone and quicklime. Of the former, some of the limestone would produce of good

marble, if properly handled. That is the case particularly at Le Roy. For making quick-lime there is amply opportunity. The only difficulty will be a competition with other localities from which transportation is light, that posses cheaper fuel for calcination. Brick can be made at almost any place in the county. Three miles northeast of Lansing Mr. John Just is engaged in brick-making. At Austin Mr. A. H. Alsip now manufactures brick. Formerly they were also made by Smith, Tuttle and Tracy, and by Horace Webb. Mr. Alsip lays his own brick in the wall for $12.50 and $13.00 per thousand, furnishing everything. He sells for $12 and $15 per thousand. He makes a sand-mold brick, free from lime, but rather soft. He burns the common surface, taking off about three inches, so as to remove the grass-roots. During the year he has made about 550,000, oak wood costing about $6.50 per cord. At Austin a light colored brick from Watertown, Wisconsin, is somewhat used. Brick from Chaska, Carver county, are delivered on the cars for $8, costing $13 at Austin. The lime used at Austin is mostly from Mitchell, Iowa. At Le Roy not many brick have been made. The Caswell house and the school house at that place are built of brick made at Le Roy. The quality of the Le Roy brick is as good as any seen at Austin. About three miles above Frankford the Shaw Brothers have begun the manufacture of a fine light-colored brick, though some are also red. This yard is said to turn out some of the best brick made in the county. To those interested in burning lime in the county the following statements obtained from Schuyler and Hulme, of Mitchell, Iowa, extensive lime-burners, will be of value. They have one draw kiln, which is in constant operation, of Page's patent, from Rochester, New York. It affords 200 bushels of quick-lime every 24 hours, It requires 48 hours to take a piece of the rock through the kiln. Every 24 hours four cords of wood are consumed, at a cost of four dollars per cord. One cord of stone is calculated to make 100 bushels of lime, at 80 pounds per bushel, which sells at the kiln at 35 cents per bushel, average price. Coarse lime will fall six pound short by measure, but if the fine lime be put in it will hold out weight, previous to being air-slacked. Air-slacked lime averages about 55 pounds per pushel. To run this kiln requires seven men, including those who take out the stone, or five men and one team.