THE GEOLOGICAL

AND

NATURAL HISTORY SURVEY

OF

MINNESOTA.

THE FOURTH ANNUAL REPORT.

FOR THE YEAR 1875.

By N. H. WINCHELL, State Geologist.

ASSISTED BY

M. W. HARRINGTON, of the University of Michigan.

SUBMITTED TO THE PRESIDENT OF THE UNIVERSITY, DEC. 31, 1875.

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1876.

STATE PUBLICATIONS RELATING TO THE GEOLOGY OF MINNESOTA.

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

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

ADDRESS AND SUMMARY STATEMENT.

To the President of the University:

The accompanying report, the fourth since the beginning of the Geological and Natural History Survey of the State, embraces full and detailed reports on the counties of Fillmore, Olmsted, Steele and Dodge. These counties lie nearly contiguous in the southeastern portion of the State, embracing some of the first settled, and now most thickly inhabited counties of the State. The plan for the season embraced other counties, in the central portion of the State, and one or more in the northern. But it has been found impossible to complete more than the four named. Considerable work has been done in Hennepin county, and some in Stearns, but the scattered observations made will be reserved till the work in those counties is taken up and reported in detail. The complicated character of the work done in Fillmore and Olmsted counties will be seen by a glance at the accompanying geological maps of those counties. The eastern portion of these counties, particularly Fillmore, falls within that well-known tract denominated by Prof. J. D. Whitney, a "driftless area." This term very nearly describes the tract as represented in this portion of Minnesota, but I have been able to discern, even in the most eastern part of Fillmore county, occasional small deposits of true northern drift, as detailed by localities in the report on that county. In the absence, or attenuation, of the true northern drift, the underlying rocks make bold and frequent outcrops, governing the immediate contour of the surface, and deciding the agricultural as well as the general industrial resources of the country. It has been necessary, therefore, to give very minute attention to the lines of outcrop of the different formations as they make their way across the county, in order to delineate them correctly on the accompanying colored maps.

In the survey of these counties I have had the assistance of Mr. W. E. Leonard, a student of the University, who accompanied me

in the earlier part of the season in Fillmore county, and of Prof. M. W. Harrington, of the University of Michigan, whose report is herewith presented. Prof. Harrington, who ably carried on the work independently in my absence, was compensated only by the payment of his field and traveling expenses. He also had the privilege of retaining such botanical specimens as he could gather, for the purpose of enlarging the already magnificent collection of plants in the museum of Michigan University, a list of all identifications being reported for our survey.

The catalogue of the plants of the State, by Dr. I. A. Lapham, mentioned in the report for 1873, has been printed by the State Horticultural Society, and is published in its report for 1875, where it is duly accredited to the Geological and Natural History Survey, to whose care Dr. Lapham had entrusted it.

In December, 1872, the Board of Regents adopted a resolution asking the representatives and senators in Congress, from Minnesota, to take measures to secure to Minnesota such determinations of latitude and longitude, by the United States Lake Survey, as are done in other States by the officers of that survey. Through the co-operation of Hon. M. H. Dunnell, representative in Congress, the Superintendent of the Lake Survey, Gen. C. B. Comstock, was induced to take immediate steps toward the determination of the latitude and longitude of the University buildings. There being no Congressional appropriation for further determinations in this State, nothing further has been done. It is desirable, in order to construct a correct map of Minnesota, that as many points as possible be established in the same manner. In the State of Michigan, the Lake Survey officers are determining one or more points in each county of the Southern Peninsula. It is done by special act of Congress, appropriating money to enable the Lake Survey to aid the State Survey. I call your attention to this matter, that further efforts may be made to carry out the intent of the original action of the Board of Regents. It is the established policy of the general government to aid those States that are carrying on geological surveys, through the instrumentality of the coast surveys, and it has been so announced. The attention of Congress should be called specially to this matter, in order that our survey may receive its share of such aid.

The following has been sent from the office of the Lake Survey, at Detroit, by order of Gen. Comstock, giving the results of observations made at the University:

Longitude of the Smaller Cupola of the University of Minnesota.

	Longitude.	References.
Longitude of Washington (Naval Observatory) west from Greenwich.	77° 03′ 00″.00	Admiral Sand's letter, February 9, 1872.
U. S. Lake Survey observatory (1857 to 1870) west from Washington (Naval Observatory.)	5 59 59. 80	L. S. Report 1871 and Office No. 8.
S. E. corner of the new Custom House, St. Paul, Minn., west from the L. S. Obs. (1857 to 1870.)	10 02 32. 25	L. S. Report 1872 and Office No. 8.
Smaller Cupola of the University of Minnesota west from the S. E. corner of the new Custom House.	0 8 36. 50	See office rept. No. —. A. R. Flint, obs'r. T. Russell, computer.
Longitude of the smaller cupola of the University of Minnesota from Greenwich.	93° 14′ 08″. 60	

	Latitude.	References.
Latitude of the S. E. corner of the new Custom House.	44. 56 42. 89	Office No. 8, from A. R. Flint, observer, 1871.
Smaller Cupola of the University of Minnesota north from the S. E. corner of the Custom House.	1 56. 33	Office rep. No. 213. A. R. Flint, ob'r, T. Russell, c'p'r.
Smaller Cupola of the University of Minnesota.	44° 58′ 39″. 22	

	Latitude.	Longitude.
Smaller Cupola of the Univ. of Minnesota	44° 58′ 39″. 22	93° 14′ 08″. 60

(Signed) O. B. WHEELER,
Compiler.

In regard to chemical work I am not informed that anything has been done since the report of 1873. From time to time the following substances have been submitted to the chemist of the survey for examination. This list is here given that the records of the survey may be easily consulted, and that in future analyses samples may readily be referred to their sources.

No. 1. Light, pinkish clay, known as "Tripoli," from Stillwater, Minn. Submitted to Prof. Strange December 10th, 1872. Reported on by Prof. Peckham. (See the Second Annual Report.)

No. 2. Red and yellowish clay, fine grained; no apparent pebbles nor sand. From Spring Valley, Minn. Submitted to Prof. Strange December 10th, 1872.

No. 3. Drab, or brown clay, with a reddish tinge, very fine and soapy to the touch; no sand nor pebbles. From Spring Valley, Minn. Submitted to Prof. Strange December 10th, 1872.

No. 4. Same as No. 2, but evidently arenaceous, and with occasional small pebbles. From Spring Valley, Minn. Submitted to Prof. Strange December 10th, 1872.

No. 5. Peat, from Schmidtz' land, St. Paul, Minn., eight feet below the surface. Submitted to Dr. P. B. Rose August 6th, 1873. Reported November 22d, 1873. (See the Second Annual Report.)

No. 6. Peat, from Schmidtz' land, St. Paul, Minn., 2 feet below the surface. Submitted to Dr. P. B. Rose August 6th, 1873. Reported Novem ber 22d, 1873. (See the Second Annual Report.)

No. 7. Manufactured Peat, from Wells; W. Z. Haight. Submitted to Dr. P. B. Rose, August 6th, 1873. Reported by him November 22d, 1873.

No. 8. Peat from Lake Emily, near St. Peter, Minn. Submitted to Dr. P. P. B. Rose, August 6th, 1873. Reported November 22d, 1873.

No. 9. Turf-peat, from Empire City. Submitted August 6th, 1873, to Dr. P. B. Rose. Reported November 22d, 1873.

No. 10. Peat from Wells, not manufactured. Submitted August 6th, 1873, to Dr. P. B. Rose. Reported November 22d, 1873.

No. 11. Cretaceous coal, cannel, from Crow Creek, near Redwood Falls, Minn. Submitted to Prof. S. F. Peckham, Sept. 6th, 1873.

No. 12. Coal, from the surface, near Bismarck, D. T. Submitted to Prof. S. F. Peckham, September 6th, 1873. [The last two have the same external characters.]

No. 13. Earthy coal, from Crow Creek, near Redwood Falls, Minn. Submitted to Prof. S. F. Peckham, September 6th, 1873.

No. 14. A mixture of charcoal and ash, apparently, from the lignite beds of the cretaceous, at Redwood Falls, Minn. Submitted to Prof. S. F. Peckham, September 6th, 1873.

No. 15. Kaolin; the result of decomposed granite, greenish, with no apparent grit. From Birch Coolie, Minn. Submitted to Prof. S. F. Peckham, September 6th, 1873. (See description of this substance, and of the locality, in the Second Annual Report.)

No. 16. Peat, from St. Cloud, 18 inches below the surface. Submitted to Prof. S. F. Peckham, September 15th, 1873. Partially analyzed and reported December 23d, 1873.

No. 17. Peat from Lura, Faribault county, Minn., 18 inches below the surface. Land of W. Z. Haight. Bog A. Submitted to Prof. S. F. Peckham, October 9th, 1873. Partially analyzed and reported December 23d, 1873. (See the Second Annual Report.)

No. 18. Peat from the same bog as No. 17, 3 feet below the surface. Submitted to Prof. S. F. Peckham, October 9th, 1873. Partially analyzed and reported December 23d, 1873.

No. 19. Peat from Lura, Bog B, 18 inches below the surface. Submitted October 9th, 1873, to Prof. S. F. Peckham. Partially analyzed and reported December 23d, 1873.

No. 20. Peat from the same bog as No. 19, 3 feet below the surface. Submitted to Prof. S. F. Peckham, October 9th, 1873. Partially analyzed and reported December 23d, 1873.

No. 21. Turf-peat, from the land of John Haggard, section 4, town 101, range 39. Submitted October 9th, 1873, to Prof. S. F. Peckham. Partially analyzed and reported December 23d, 1873.

No. 22. Peat from K. K. Peck's land, near Windom, 3 feet below the surface. Submitted October 9th, 1873, to Professor S. F. Peckham. Partially analyzed and reported December 23d, 1873.

No. 23. Peat from K. K. Peck's land, near Windom, 2 feet below the surface. Submitted October 9th, 1873, to Professor S. F. Peckham. Partially analyzed and reported December 23d, 1873.

No. 24. Peat, from the land of Rev. Edward Savage, near Windom, Minn., 18 inches below the surface. Submitted October 9th, 1873, to Prof. S. F. Peckham. Partially analyzed and reported December 23d, 1873.

No. 25. Turf-peat, from S. O. Taggart's land, section 24, town 105, range 35. Submitted October 9th, 1873, to Prof. S. F. Peckham. Partially analyzed and reported December 23d, 1873.

No. 26. Peat from land of A. A. Soule, Mountain Lake, Minn., 2 feet below the surface. Submitted October 9th, 1873, to Professor S. F. Peckham. Partially analyzed and reported December 23d, 1873.

No. 27. Peat from the land of the St. Paul and Sioux City Railroad, section 13, town 106, range 37, 2 feet below the surface. Submitted to Prof. S. F. Peckham, October 9th, 1873. Partially analyzed and reported December 23d, 1873.

No. 28. Peat from the land of F. G. Taylor, Brooklyn, Hennepin county. Submitted to Prof. S. F. Peckham, October 9th, 1873. Partially analyzed and reported December 23d, 1873.

No. 29. Lumps from the sandstone near the Red Jacket Mills, in Blue Earth county, apparently magnesia, or magnesia and lime. (See description of that locality in the report for 1873.) Submitted to Prof. S. F. Peckham. Partially examined and reported December 23d, 1873.

No. 30. Green specks in the *St. Lawrence limestone.* Sample from St. Lawrence. Submitted to Prof. S. F. Peckham. Partially examined and reported December 23d, 1873.

No. 31. Green specks from the *St. Lawrence limestone.* Sample from Judson. Submitted to Prof. S. F. Peckham. Partially examined and reported December 23d, 1873.

No. 32. Black mineral, accompanying quartz. The quartz occurs in decomposed granite, at Minnesota Falls. The mineral has the appearance of specular peroxide of iron, but is thought by the owners to be a mineral of value. Submitted to Prof. S. F. Peckham, who pronounced it haematite iron ore. (See the description of this locality in the Second Annual Report.)

No. 33. Turf-peat, town 101, range 40, section 27. Submitted to Prof. S. F. Peckham, March, 1874.

No. 34. Peaty lake sediment, Bigelow, Minn. Submitted to Prof. S. F. Peckham, March, 1874.

No. 35. Peat, from Red Wing, land of Capt. O. Eames. Submitted to Prof. S. F. Peckham, March, 1874.

No. 36. Peat from C. F. Bryan's land, near Winona, Minn. Submitted to Prof. S. F. Peckham, March, 1874.

No. 37. Ore from the Sauk Valley, said to have been taken from the bottom of a shaft sunk in exploration for coal. Submitted to Prof. S. F. Peckham.

No. 38. Ore, supposed to be of silver, from Colorado, from J. B. Culver. Duluth, Minn. Submitted to Prof. S. F. Pechham, September 15th, 1874. Reported to Mr. Culver.

No. 39. Ore, supposed to be of silver, from E. F. Kindred, Brainerd, Minn. Submitted to Prof. S. F. Peckham, September 18th, 1874. Reported to Mr. Kindred.

No. 40. Ore, supposed to be of silver, from the north shore of Lake Superior, near Duluth, from H. Burg. Submitted to Dr. P. B. Rose, November 20th, 1874. Reported December, 1874, and forwarded to Mr. Burg.

No. 41. Ore from M. L. Casey, supposed to be of iron, from the corporate limits of Duluth. Submitted to Prof. S. F. Peckham, December, 1874.

No. 42. Sample of mineral water from the Belle Plaine Salt Springs. Submitted to Prof. S. F. Peckham, October, 1873. Partially analyzed and reported December 23d, 1873.

No. 43. Fragment of native copper, apparently, from R. S. Russell, Pleasant Grove, Olmsted county. Submitted to Mr. D. P. Strange in the winter of 1872 and '73. Reported by Prof. S. F. Peckham, December 23d, 1873.

No. 44. Sample of water from the Belle Plaine Salt Springs. Submitted to Prof. S. F. Peckham, October, 1873. Partially analyzed and reported February 16th, 1874.

The accompanying report also embraces a statement of operations in the Museum since the date of the last report thereon. The law ordering the Geological and Natural History Survey contains a clause as follows:

SEC. 6. It shall be the duty of said board of regents to cause proper specimens, skillfully prepared, secured and labeled, of all rocks, soils, ores, coals, fossils, cements, building-stones, plants, woods, skins, and skeletons of animals, birds, insects and fishes, and other mineral, vegetable and animal substances and organisms discovered and examined in the course of said surveys, to be preserved, for public inspection, free of cost, in the University of Minnesota, in rooms convenient of access, and properly warmed, lighted, ventilated and furnished, and in charge of a proper scientific curator. * * *

This clearly establishes in the University a State Cabinet or Museum of Natural History. A report on the progress of the survey, in compliance with law, implies a report on the condition of its collections. Hence it seems proper that hereafter the report on the museum should be embraced in that on the progress of the survey. With the establishment of the State Museum at the University

arises the necessity for cases for the exhibition and proper keeping of the collections, and other current expenses involved in their transportation, labeling and custody. Objects of Natural History, requiring careful and often expensive preparation, must be constantly watched and frequently cleansed, to prevent their deterioration and destruction. The mounting of mammals and of birds is expensive. To carry on a system of exchanging, with other institutions, as ordered by the law, involves an outlay of money. None of these expenses have been provided for. The legislature should make an annual appropriation of several hundred dollars to enable the Regents to carry out that part of the law. It will require, at once, about a thousand dollars to fit up the rooms assigned to the use of the Museum, with suitable cases and other appliances.

I wish to call to your serious attention, the propriety of taking steps to place on an active footing other portions of the work ordered by the general law of March, 1872. Sundry practical questions involving the industries of the state and the confort of the people, have arisen since the inception of the survey; and the demand for their solution, by efficient means and in an authoritative manner, has sought expression in attempts at special legislation, creating special commissions for the purpose of investigation and report. These practical questions, which really depend, in their ultimate results, on the means taken to investigate under the guide of science, and to modify or control their operations, are covered by the terms of the general law of March, 1872. I refer to an examination of the peat deposits, and to the collection of statistics concerning the late incursion of the western grasshoppers into the state. If the general law were put into vigorous execution, with ample means, there would be no inducement to originate special commissions to perform the various portions of the work ordered. It seems to me these departments ought not to rest much longer without making a systematic beginning. If nothing more is done than to keep up an organization, with little expense, such organization would be ready in case any public emergency arises to take the work in hand, and to furnish information immediately concerning its proper treatment. In the mean time, any special commission, created to perform work required by the terms of the general law, should be made subject to the Board of Regents, and all official reports on scientific investigations, covered by that law, ought to be made as so much contributed to the progress of the Geological and Natural History Survey. Then the state will not find herself duplicating her employes, and performing twice the same service. Then all these in-

vestigations will be judiciously supervised, and the scientific work of the state will be harmonized in all its relations.

Germane to the work of the geological survey, is the collection of a set of the building stones, minerals, limes and soils of the state, for exhibition at the Centennial Exposition, to be held at Philadelphia in the year 1876. The State Board of Centennial Managers having requested the aid of the Geological Survey in making a suitable collection of the objects named, the Board of Regents, through their Executive Committee, authorized me to superintend their collection. Although the desires and plans of the State Board of Centennial Managers have been very widely published, and considerable personal appeal has been resorted to, the present condition of the meager collections thus far made does not warrant ardent expectations that this branch of the exhibition on the part of Minnesota will be creditably sustained.

In submitting this report, I take pleasure in acknowledging the aid of the people of the counties reported on, and especially of Prof. M. W. Harrington, of Ann Arbor, whose former connection with the geological survey of Michigan enabled him to conduct the field work independently, releasing me for other duties.

Very respectfully,

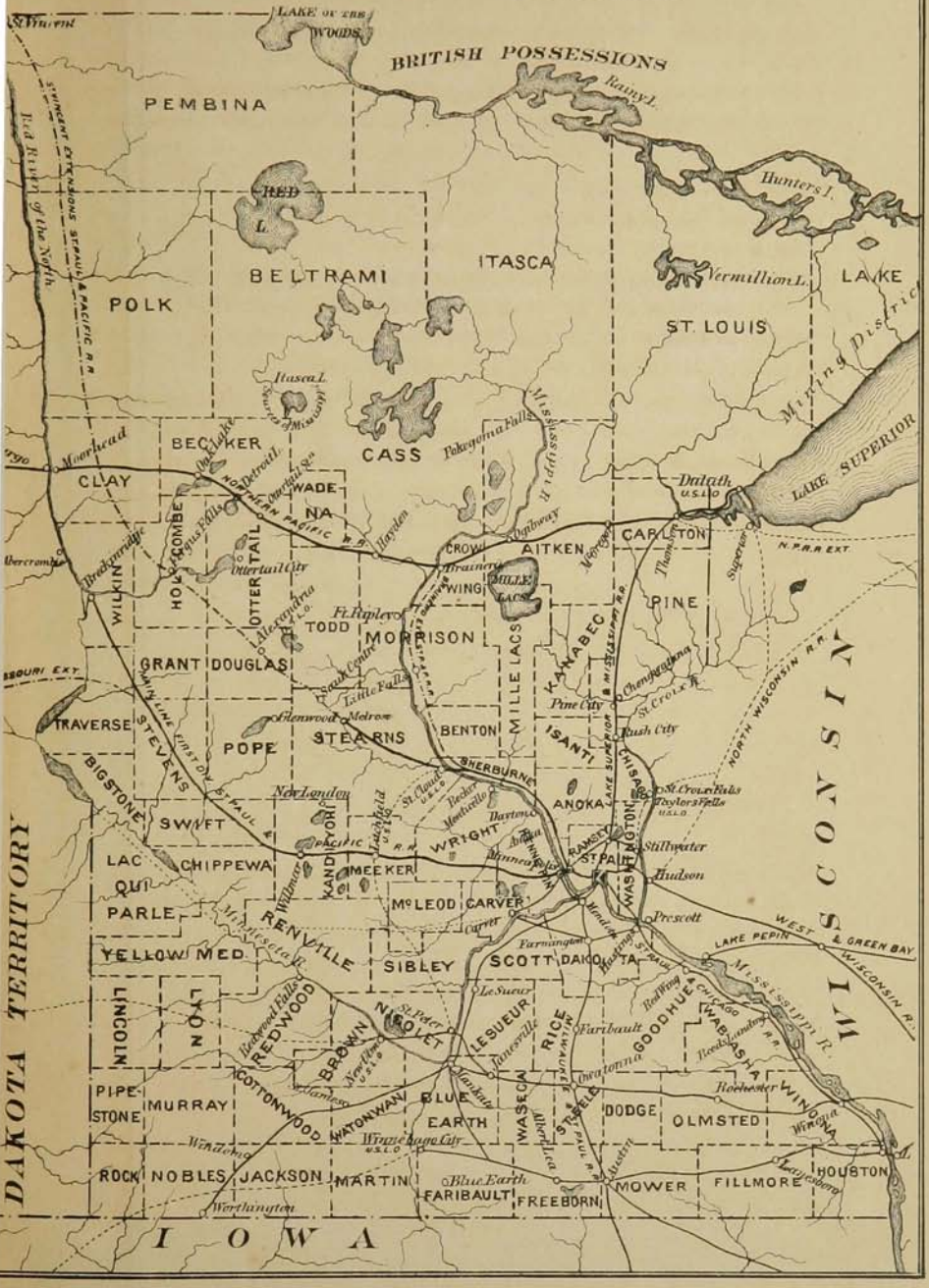
N. H. WINCHELL.

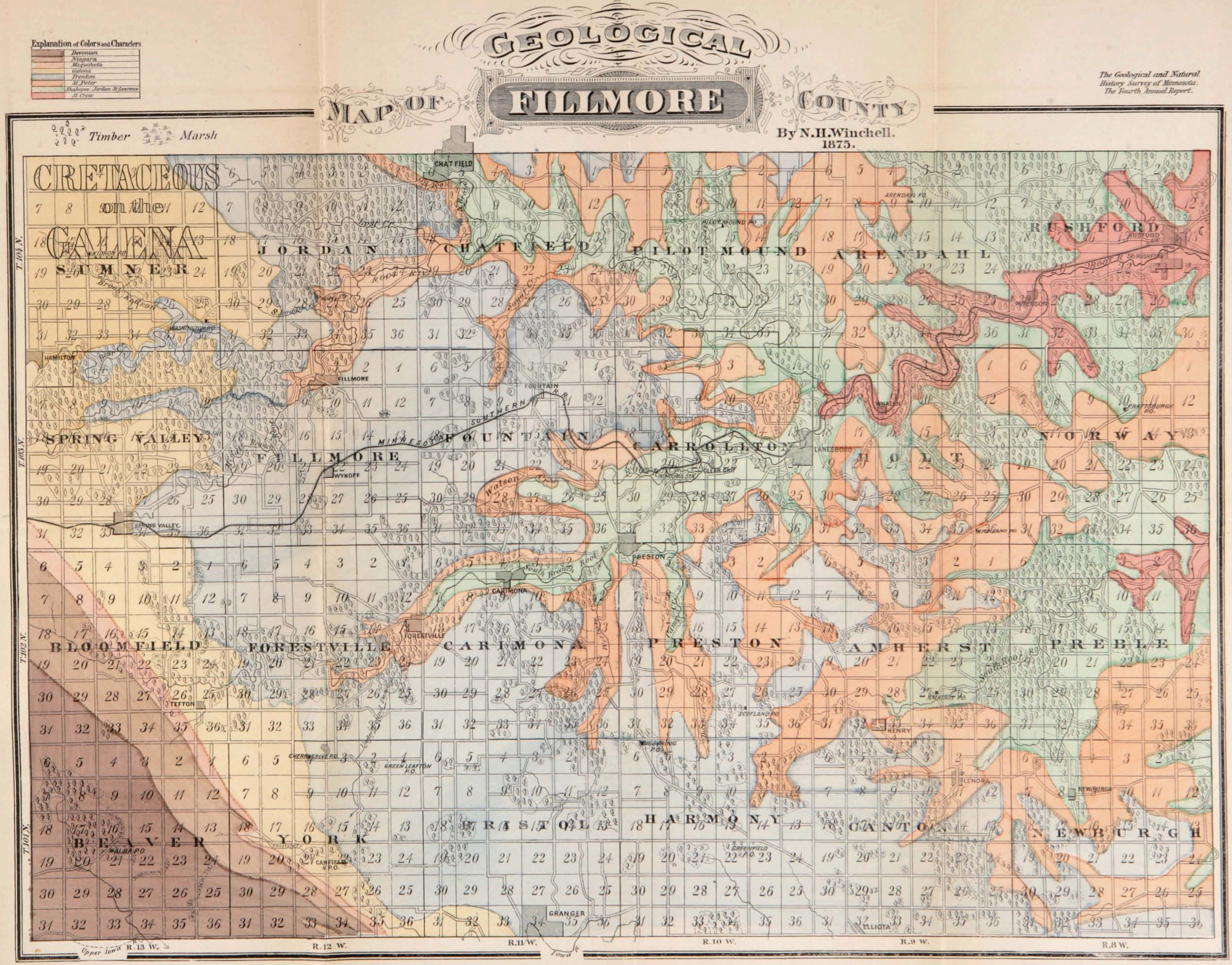
THE UNIVERSITY OF MINNESOTA,
Minneapolis, Minn., Dec. 31, 1875.

MAP OF
MINNESOTA.

Showing Locations of the Counties.

Total area 83,531 Square miles.




GEOLOGICAL
MAP OF FILLMORE COUNTY
By N.H.Winchell.
1875.
The Geological and Natural History Survey of Minnesota. The Fourth Annual Report.
Explanation of Colors and Characters
Devonian
Niagara
Maquoketa
Galena
Trenton
St. Peter
Shakopee, Jordan, St. Lawrence
St. Croix
Timber
Marsh
CRETACEOUS on the GALENA
SUMNER
JORDAN
CHATFIELD
PILOT MOUND
ARENDAHL
RUSHFORD
SPRING VALLEY
FILLMORE
FOUNTAIN
CARROLLTON
HOLT
NORWAY
BLOOMFIELD
FORESTVILLE
CARIMONA
PRESTON
AMHERST
PREBLE
BEAVER
YORK
BRISTOL
HARMONY
CANTON
NEWBURGH
CHATFIELD
HAMILTON
FILLMORE
FOUNTAIN
WYKOFF
SPRING VALLEY
LANESBORO
PRESTON
CARIMONA
FORESTVILLE
TEFTON
HENRY
GRANGER
ELLIOTA
LENORA
NEWBURG
RUSHFORD
PETERSON
WHALAN
MINNESOTA SOUTHERN R.R.
Root River
South Branch Root R.
Watson Cr.
Upper Iowa
T. 104 N.
T. 103 N.
T. 102 N.
T. 101 N.
R. 13 W.
R. 12 W.
R. 11 W.
R. 10 W.
R. 9 W.
R. 8 W.

REPORT ON THE GEOLOGY OF FILLMORE COUNTY.

Situation and Area.

Fillmore county lies adjacent to the State of Iowa, and is separated from the Mississippi river by Houston county. It lies next east of Mower county, which was reported on last year. It has a width, north and south, of four government towns, each six miles square, and a length, east and west, of six, making it one of the largest of the organized counties. Its area is about 864 square miles, or 553,081.77 acres, according to the records of the State Land Office. It contains no lakes, and but few acres that are unsuited to farm tillage. Preston is the county seat. Lanesboro, Spring Valley, Chatfield and Rushford are the principal towns.

Natural Drainage.

Root river, with its tributaries, drains nearly the whole of the county. The Upper Iowa river, which enters the county in Beaver and Bristol townships, receives a few small streams from the southern tier of townships. Root river, flowing toward the east, spreads out its tributaries north and south, like the rays of a fan, crossing the entire county from west to east. Many of the branches of Root river rise in the counties next west and north of Fillmore county, in a tract of country covered with northern drift. After entering Fillmore county, they soon enter canon-like valleys, and the drift becomes much lighter. They then converge toward the main valley, following deeply cut rocky valleys, and leave the county in one volume at Rushford, in the northeastern corner of the county. These streams furnish frequent water-power privileges, and a number of them have been improved in the erection of mills, which are scattered throughout the county as follows. There are, besides these, several smaller saw mills:

At Chatfield, two flouring mills.
On the southeast quarter of section 17, Chatfield, one flouring mill.
At Clear Grit, one flouring mill.
On section 31, Jordan, one saw mill.
At Preston, one flouring and one woolen mill.
At Carimona, one flouring mill.
At Forestville, one flouring mill.
At Ætna, one flouring mill.
At Fillmore, two flouring mills.
At Baldwin's Bridge, (section 21, Forestville,) one saw mill,—also fitted for grinding feed.
At section 24, Bloomfield, (De For,) one flouring mill.
At Granger, two flouring mills.
On South Root river, three flouring mills.
At Rushford, three flouring mills.
At Peterson, one flouring mill.
At Whalen, two flouring mills.
At Lanesboro, three flouring mills.
On Bear and Deer Creeks, in the northwestern part of the county, eight flouring and four saw mills.

At the Tunnel Mills, section 34, Sumner, advantage has been taken of the winding course of Bear Creek. The creek is enclosed on both sides by high rocky walls. A tunnel has been cut through a narrow neck, excavated in the rock, admitting the water, which falls again into the river, on section 34, producing a fall of 25 feet in 600 feet. The cut in the rock is 600 feet long, for the tunnel, and 100 feet for the tail race. At G. Weisbeck's Mill, a similar opportunity is offered. This is on section 11, Spring Valley. By a tunnel of 70 feet, through the "Hog's back," a fall of 17 feet 10 inches may be secured; and at the lime kiln of Mr. J. H. Hall, near Weisbeck's, a tunnel of 125 feet will furnish a power of 20 feet. About 20 rods from Weisbeck's, a tunnel of 450 feet will afford 64 feet head of water. The rock is limestone, in horizontal bedding.

Surface Features.

That portion of the county which is covered with a thick deposit of foreign drift presents the usual monotony of surface, characteristic of the drift latitudes. This includes the most of the western range of townships across the western end of the county, and some portions of the next range east. There are, however, even within the drift area, a number of narrow, deeply cut valleys, with precipitous, rocky bluffs, having very much the nature of canons, like those of the driftless territories of the west. Toward the east

these deeply cut valleys are more numerous. All the little streams, and a great many narrow valleys that have no running water in them, have high, rocky bluffs along their whole course. These vallies and streams, constituting the drainage system of the county, converge toward the valley of Root river. The valley of this stream, with its principal tributaries, presents some of the most remarkable and instructive phenomena of erosion to be found in the state. It passes nearly at right angles across the strike of the formations. These are alternating limestones and sandstones, with an occasional bed of soft shale. The Trenton limestone, underlain by the easily eroded St. Peter sandstone, the same as at the falls of St. Anthony, although about a hundred and sixty feet in thickness, is eaten into by the retroaction of the water as it plunges over the falls at the point where the streams cross the line of its superposition over the St. Peter, until they have each excavated in the Trenton a deep channel from 15 to 30 miles in extent. Through the line of strike of the St. Peter these valleys are widened out, the surface of the low ground within the bluffs being usually one of rich meadow with undulating surface, from one to two hundred feet below the general level. The Lower Magnesian Formation is entered upon by the streams while they are yet a good many miles within the general area of the Trenton. As this formation consists of three members, (two limestones, separated by a sandstone about 30 feet in thickness,) it repeats the succession of phenomena witnessed in the erosion of the Trenton and St. Peter. As the water leaves the Shakopee limestone and enters upon the Jordan sandstone, it passes over a series of rapids, or a fall of several feet perpendicular, which falls or rapids undergo a process of recession under the same causes as produce the recession of the Ttrenton-St. Peter falls. Again, when the stream passes from the St. Lawrence limestone upon the St. Croix sandstone the same conjunction of circumstances causes another rapid or water-fall. Thus by a series of steps, more or less evident, the branches of Root river descend from the area of the Galena limestone to the St. Croix sandstone. The valleys widen in the sandstone areas, and become abruptly narrow in the limestone belts. In passing down a stream, within a sandstone area, where the valley is perhaps half a mile wide, with tilled farms in the bottom land, the high bluffs being remote from the stream, the first indication of an approaching change in the formation is the rise of a terrace along the immediate river bank, with an occasional exposure of lime rock facing the water. This terrace, which becomes almost continuously rocky, rises slowly till it exposes the full

thickness of the rock which causes it. On the other hand, the first evidence of a change from limestone to sandstone, visible in descending the stream, is the occurrence of a waterfall or rapid. Such changes produce water-powers, many of which have been improved. Hence, the location of a flouring mill, on one of these branches, is an intimation to the geolgist that at that point one of his boundary lines crosses that stream. Around these points gathered the first village settlements. Preston is located where the water-power formed by the descent of the river from the Shakopee on to the Jordan induced the construction of mills. The water-power at Chatfield is formed in the same way. Near Fillmore the branches of Root river, known as Deer and Bear creeks, afford good water powers by their descent from the lower Trenton to the St. Peter. Mills have been built at both points. On the south branch of Root river, above Forestville, the stream leaves the Trenton, and the waterfall has been improved in the same manner, at Baldwin's Mill. The same fact is illustrated by a great number of eastward flowing streams, in the eastern border counties, between Fillmore county and the falls of St. Anthony at Minneapolis. Of course, rapids are also likely to be formed, especially in small streams, when passing through the areas of rock of uniform hardness. Such water-powers, and others that are formed by the construction of dams, do not fall into this class.

While the immediate valleys of Root river and its tributaries are apt to be rocky, the country that spreads out in either direction, after leaving the valleys, is not rough. It is rolling, or undulating. In the eastern portion the rocks are covered by a heavy deposit of rich, clayey, loam, known as the *loess*, which fills up many depressions and lends a uniform and remarkable fertility to the soil. It constitutes the soil. The farms are all well drained, naturally. The county contains no lakes. In York township there is a slough which on some maps is represented as a lake. It is about a quarter of a mile across. The Trenton area is distinctly separated, topographically, from that of St. Peter and the lower formations. From the Trenton to the Lower Magnesian the surface descends by a step or terrace, about 125 feet. Some of the Trenton areas are isolated from the main area, and constitute small tables or mounds, which are well known as "Trenton mounds" in the early reports. Some travelers have referred them to the agency of the ancient "mound builders," and a good many of the residents, who are not aware of the geological causes that have produced them, still believe that they are artificial instead of natural. From some of the elevated Trenton

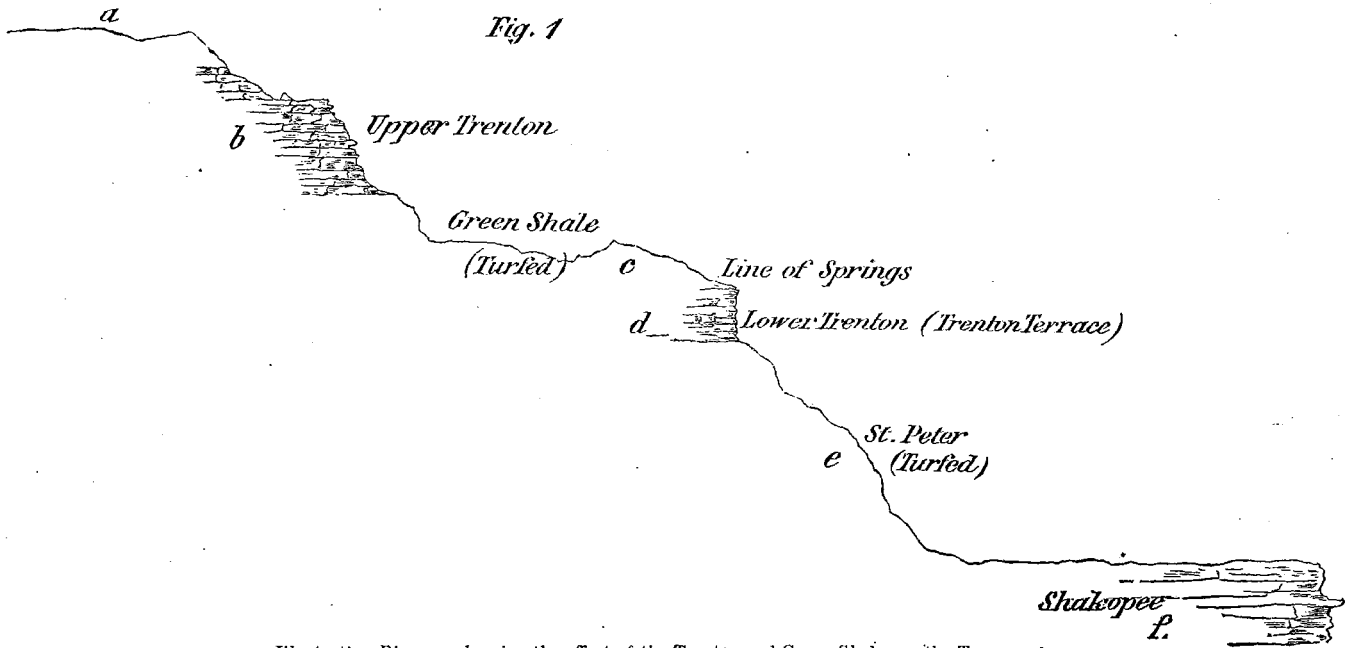
areas, overlooking the river valleys, magnificent views of landscape may be had. From the elevated Trenton area in Newburg township, the eye looks over the valley of S. Root river, and can almost discern the Trenton bluffs on the opposite slopes of Root river in the northern part of the county. From the peninsula of the Trenton running north between Camp and Willow creeks, in Preston township, the village of Fountain is plainly discernible across the valleys of the S. Branch of Root river and Watson's creek, with a wide expanse of alternating timber and prairie between, while on either side is a broad undulating valley of prairie land. On the east is Camp creek valley, and on the west is that of Willow creek. These valleys are deep and wide, but owing to the thickness of the loess loam, the slopes are gentle and broad, and, in the fall of the year, when the industry of the farmer is exhibited in the plowing of his wheat fields, and the threshing of his last crop, in every direction may be heard the rattle of threshers, often running by steam, and may be seen a hundred teams preparing for the next harvest. Another magnificent view may be obtained from the Trenton peninsula on secs. 10 and 15 in Carrollton. From here the view extends north over the valley of Root river to the Trenton bluffs along the north boundary of the county, a distance of over forty miles, and toward the south over the valley of the S. Branch of Root river, looking over Preston and Lanesboro, which are situated within the river bluffs, so far below the general level of the country, that they can be seen but a short distance before reaching them. Further down Root river valley, the gorge in which the river runs becomes wider, being at Rushford, about two miles in width with fine farm lands in the bottoms. The bluffs are rounded off with age and have a thin soil, generally turfed, though showing frequent rock exposure. The river is there 565 feet below the tops of the bluffs, as measured by aneroid. At Whalen, in Holt township, the river is, by the same measurement, 470 feet below the top of the Trenton terrace on sec. 20. Whalen's Bluff is 250 feet high above the river. At Lanesboro, in Carrollton, the river is 285 feet below the immediate river bluffs, which consist wholly of the Lower Magnesian formation, and about 440 feet below the top of the Trenton terrace on sec. 20, Holt. At Preston the river at the stone mill is 335 feet below the Trenton terrace, which forms the general level about a mile south of the village. At Isinours Station the river runs 145 feet below the top of the Shakopee limestone which forms there the brow of the immediate river bluffs. At Forestville, the height of the country, north of the village, above the river, is 285 feet. The immediate

river bluffs are 190 feet above the mill pond. At Chatfield, the river is about 222 feet below the general level of the country. At Fillmore, the prairie upland is 200 feet above the river level. From Fountain to Isinours station, the track of the Southern Minnesota railroad descends 401 feet, passing from the upper Trenton to the St. Lawrence, and entering the latter formation about 25 feet, the rocks all lying nearly horizontal At Weisbeck's Mill, on Deer Creek, section 11, Spring Valley, the river is 205 feet below the general level of the country. There is here a little drift, but the cut is mostly in the Galena and Trenton limestones. The village of Fountain is about 350 feet higher than the terrace, at Preston, on which the Stanwix House stands. These measurements might be multiplied, but enough have been given to show the unevenness of the surface, due to erosion. The rocks lie everywhere nearly horizontal. The varied topography of the county is due to the influence of running water, and atmospheric forces, on the rocks, combined with their alternations of limestone with soft sandstone. The limestones are firm, and resist these forces much longer than the sandstones. They alternate in the following manner, in descending order:

Trenton limestone.
St. Peter sandstone.
Shakopee limestone.
Jordan sandstone.
St. Lawrence limestone.
St. Croix sandstone.

The limestones form the prominent features in the topography. They have the most frequent outcrops. They project along the summits of the bluffs, and constitute the brows of benches or terraces that diversify the county. The sandstones never, or very seldom, appear in the tops of the bluffs. They outcrop in sheltered nooks, or below the line of the limestone exposure. They are more likely to be hid by soil and turf. The lower Trenton contains, besides about 20 feet above the St. Peter sandstone, a layer of easily eroded green shale, which, outcropping by roadsides, introduces a series of springs and muddy spots, being impervious to water, that invariably follows that boundary line wherever it goes. It withstands the disintegrating action of the elements even more successfully than the limestones themselves. For that reason it protects that portion of the Trenton which lies below it, long after that which lies above it has been entirely denuded. The strike of the upper Trenton is often driven back several miles from that of the lower Trenton. The lime rock which lies below this shale is about 20 feet

thick. The singular Trenton mounds, which have already been mentioned, are composed of the lower Trenton protected by a greater or less thickness of the green shale, and a portion of the St. Peter sandstone. The subjoined diagram illustrates the manner of weathering down of the Trenton and St. Peter. Instances of this may be seen in almost any square mile, in the loam-covered area, along the outrunning strike of the Trenton.



Illustrative Diagram showing the effect of the Trenton and Green Shales on the Topography.

At *a* the Trenton has its full thickness, about 160 feet. Such a point may be found at Fountain; *b* represents an outcrop of the upper Trenton, as seen along the gorges that are frequent in the Trenton area. Such an outcrop is visible at the "Big Spring," a few miles northwest of Fountain, where the water rushes out in a great volume near the base of the bluff, and probably on a level with the top of the Green Shale. At *c* is a marshy tract, or one that is gently sloping, having a springy margin, near the brow of the lower bluff. Such spots are visible particularly at Chatfield, in the northern part of the village, near Jacob's lime-kiln, and west of there. A fine illustration of the effect of this shale on the surface drainage may be seen in section 35, Holt, where a copious spring issues from near the top of the mound of Trenton, the water being shed by the shale overlying, and is gathered by troughs into a tank for watering stock. *d* represents the outcropping edge of the lower Trenton, It is this which is seen in the summits of the isolated mounds, and which forms the conspicuous shoulder that exists wherever the strike of the lower Trenton crosses the county. The slope *e* is occupied by the St. Peter sandstone. Sometimes this is quite precipitous, and its upper forty or fifty feet are very apt to be, but its lower portion is generally very gently descending, so that it is impossible to determine when it is replaced by the Shakopee which underlies it. The horizontal distance between *b* and *d* is sometimes several miles. This is apt to be the case along the eastern margin of the Trenton area. Indeed the detached Trenton areas in Holt and Amherst, and notably that in Pilot Mound, townships, comprise only this lower portion of the Trenton. The Shakopee limestone, *f*, underlying the St. Peter, is that which occurs along the tops of the immediate bluffs of the river, as at Preston, Lanesboro, Clear Grit and Whalen. At Chatfield it is seen at the mill, and rises about thirty feet above the river.

Throughout the Trenton area are found a great many depressions that are well known as "sink-holes." These consist of broken down spots in the drift, or loam, where it had been spread over a pre-existing canon in the rock. In some places they are very numerous, but they are confined, so far as known, with but a single exception, to the Trenton areas. They throw some light on the condition of rocky surface prior to the period which witnessed the spreading of the drift. The rock was wrought, at least in Fillmore county, in very much the same manner as we now see it along the river gorges. The immense valleys of erosion which we see, not only in Fillmore county, but also throughout the tract that has been denominated the "Driftless area," were excavated before the glacial

period. When the streams of the present time run in such gorges they have been so located by the exigencies of surface drainage and erosion since the glacial epoch. That these gorges antedate the glacial period is shown by their existence beneath the glacial drift. These sink-holes sometimes occur in lines, and with increasing frequency and size toward a large valley, and at last coalesce so as to form a continuous valley, though frequently without running water, that becomes tributary to the larger gorge. These gorges under the drift can sometimes be traced for some distance by a series of successive sink-holes. Sometimes streams are lost in them, and reappear at lower levels. There are several well-known subterranean passages in the county. Lost Creek, in Jordan township, and the Brook Kedron, in Sumner, both have underground passages for several miles. Canfield Creek, south of Forestville, runs underground about twelve miles, and, finally, the south branch of Root River sinks on the northeast quarter of section 19, Forestville, and runs undergrouud, except in high water, to about the center of section 21, where it reappears again. These underground passages are in the area of the Trenton. They indicate the corrugated surface the country presented prior to the overspreading of the drift and loess loam. The Trenton cannot be supposed to have been any more subject to such causes as produced this channeling in the rock than the other formations of the Lower Silurian. There is some reason, however, why these gorges are found almost entirely confined to that limestone. As has been said, the rest of the Lower Silurian consists of alternating sandstones and limestones, which conduces to their breaking down laterally, the sandstones easily crumbling out. The Trenton limestone, on the other hand, while it has a thickness of 160 feet, more or less, has, near its base, a bed of impervious shale, which prevents the downward infiltration of the surface water, and protects the underlying sandstone. Hence the erosions that operate laterally, in tearing down the other Lower Silurian formations, are occupied, in the Trenton limestone area, in cutting narrow perpendicular gorges. For this reason the Trenton area is everywhere the highest in the county. From the eastern boundary of the Trenton, looking east, one beholds a broad landscape lying several hundred feet, in some places, below him, the effect of the more rapid denudation of the rocks of that portion of the county. Into such narrow gorges neither the drift nor the loess loam, however deposited, would enter with such compactness as to close up the pre-existing water courses; and when partially closed up, as they were wherever sink-holes have since appeared, they have been undergoing ever since a process of re-excavation. This

process is revealed in the occasional collapsing of the surface soil, and the formation of a new sink-hole, and in the enlargement of others, since the settlement of the county. The following notes on the various towns of the county show the distribution of timber, the area and the magnetic variation at the time of the United States township survey (1854.) The distribution of timber, however, as herein noted, varies somewhat from the actual facts as existing at the present time. The areas of timber as they exist now, are more correctly shown on the accompanying map, which is based on that of the county published in Andreas' Atlas of Minnesota.

In addition to the timbered areas as here noted, a great proportion of the county is covered with bushes which are composed of hazel, aspen, oak (two sorts) and, where these are wanting, a species of low willow which seems to come up first after the prairie fires are stopped. After the willow, hazel and oak and aspen gradually come in, and in time convert the original prairie to a bushy or timbered region. Over a great deal of the county this process is going on. There are thousands of acres of young native timber not exceeding five or six inches in diameter.

The general elevation of the county above the sea may be seen from the following points along the Southern Minnesota R. R.:

Rushford Depot	711 feet.
Lanesboro Depot	831 feet.
Isinour's Station	888 feet.
Fountain Depot	1,289 feet.
Grand Meadow, Mower County	1,325 feet.

Notes from the Surveyor's Plats of Towns of Fillmore Co.

Newburg. T. 101 *N., R.* 8 *W.*

A large portion of this town is prairie. In the N. W. corner the S. Branch of Root river introduces a broken and wooden tract in secs. 6, 5 and 4. Thickets of small timber are found in the central and southwestern portions, and also in the northeast. Magnetic Variation 4° 45′ to 9° 22′. Area, 23,045.54 acres.

Preble. T. 102 *N., R.* 8 *W.*

This town is mainly wooded. It is crossed in the northeasterly direction by the south branch of Root river, which, with its tributaries brings in a great diversity of surface. There is a small

prairie patch in sections 25, 26, 34, 35 and 36. Magnetic Variation 6° 10′ to 9° 12′. Area, 23,053.60 acres.

Norway. T. 103 *N., R.* 8 *W.*

An irregular patch of prairie enters this town from the south and west, becomes narrow in the central portion, but expands to three miles in extent N. and S. in the northeastern. This prairie belt is a divide between the tributaries of the South Branch and of Root river, and is broken into by the bluffs that accompany those tributaries and extend beyond the limit of flowing water. Variation 6° 46′ to 9° 10′. Acreage, 23,012.08.

Rushford. T. 104 *N., R.* 8 *W.*

The only prairie land found in this town is that along the bottom land of Root river lying within the rock bluffs. This is marshy, except along the tributary valleys. Root river crosses the central part of the town, and flows several hundred feet lower than the level of the adjoining country. Magnetic Variation 5° 45′ to 9° 6′ Acreage, 23,149.13.

Canton. T. 101 *N, R.* 9 *W.*

This township is wooded, except in the northeastern and southeastern portions, and a small area entering from the west covering secs. 18 and 19. Mag. Var. 7° 5′ to 10° 56′. Acreage, 23,054.32.

Amherst. T. 102 *N., R.* 9 *W.*

The larger portion of this town is prairie, broken with patches of thicket and heavier timber. Mag. Var. 7° 42′ to 10° 50′. Acreage, 23,045.72.

Holt. T. 103 *N., R.* 9 *W.*

A prairie tract covers secs. 25, 35 and 36, and a portion of 31. With this exception, and the wet prairie within the river bluffs, this town is wooded. The Root river passes through sections 7, 8, 9, 3 and 2. Mag. Var. 5° 12′ (N. side of sec. 3) to 14° 51′ (N. side of sec. 5). Acreage, 23,046.70.

Arendahl T. 104 *N., R.* 9 *W.*

The prairie portion is in the northwest and centre. A belt of timber skirts along the northern boundary, and on the east unites with the timber of the Root river valley in the southeast. About one-half of the town is timbered. Mag. Var. 5° 21′ to 17°. (The former is on the south side of sec. 33, and the latter on the southwest part of the same section.) Acreage, 23,007.34.

Harmony. T. 101 *N., R.* 10 *W.*

This town is represented as all wooded except about one section, covering parts of 14, 13, 23 and 24; and about half a section covering contiguous portions of secs. 18 and 19. (There seems to be an error in the plat of this town. The central portion is probably prairie.) Mag. Var. 9° 25′ to 12°. Acreage, 23,013.72.

Preston. T. 102 *N., R.* 10 *W.*

This town is greatly diversified with frequent changes from prairie to thicket and timber. The Root river, which enters it in section 6, soon leaves it on section 5, but by its deeply eroded valley has brought in a marked diversity of surface, accompanied by more or less timber. Mag. Var. 9° 17′ to 12° 12′. Acreage, 23,008.29.

Carrollton. T. 103 *N., R.* 10 *W.*

There is but little prairie in this town. The only parts so represented being in sections 35 and 36, and the northern portion of section 6. A tract of heavy timber occurs in the northwest, sections 7 and 8. The valley of the Root River, though very rough, is not always wooded. Mag. Var. 6° 12′ to 13° 45′. Acreage, 23,026.34.

Pilot Mound. T. 104 *N., R.* 10 *W.*

In the northeastern part there is a prairie tract and also in the northwestern, but the greater portion is represented as wooded, or covered with brush and thickets. The Root river, which crosses it in a southeasterly direction, brings in a deep valley of erosion, with rock-bound bluffs several hundred feet high. Var. 8° 51′ to 13° 45′. Acreage, 22,998.57.

Bristol. *T.* 101 *N.*, *R.* 11 *W.*

This town consists of prairie and thickets, a belt of the former, widening to 5 miles toward the west, crossing it from east to west. Mag. Var. 10° 20′ to 12° 40′. Acreage, 23,026.98.

Carimona. *T.* 102 *N.*, *R.* 11 *W.*

There is an area of prairie in the southwestern corner of this town, but the most of the town is covered with sparse timber, with patches of heavy timber. It has a great many "sink holes." Mag. Var. 8° 30′ to 12° 15′. Acreage, 23,071.37.

Fountain. *T.* 103 *N.*, *R.* 11 *W.*

A great many "sink holes" also are found in this town. It has small patches of timber or oak thickets, scatterred over the whole area, and a considerable heavy timber along the streams. Watson's creek crossing it from west to east, is the cause of a considerable diversity of surface. Var. 8° 5′ to 11° 6′. Acreage, 23,103.77.

Chatfield. *T.* 104 *N.*, *R.* 11 *W.*

The North Branch of Root river, with its various tributaries, causes a rough and sometimes rocky character of surface to prevail in much of this town. It has but little real prairie, though there are openings in the thickets and oak bushes that are without timber. Mag. Var. 7° 51′ to 11° 2′. Acreage, 23,022.63.

York. *T.* 101 *N.*, *R.* 12 *W.*

A tract of wood and thicket crosses this town N. and S., about two miles wide, east of the center. The rest is prairie. Mag. Var. 9° 49′ to 11° 43′. Acreage, 23,076.54.

Forestville. *T.* 102 *N.*, *R.* 12 *W.*

The central part of this town is covered with timber and small oaks and aspens. It has a tract of prairie in the N. W. and in the S., both together covering about six sections. It abounds in sink holes. Mag. Var. 9° 41′ to 12° 2′. Acreage, 23,205.28.

Fillmore. *T.* 103 *N.*, *R.* 12 *W.*

There is a region of heavy timber west of the Middle Branch of Root river, in this town. The rest is prairie interspersed with thickets and patches of oak brush and aspen. Mag. Var. 8° 40′ to 11° 42′. Acreage, 23,032.33.

Jordan. *T.* 104 *N.*, *R.* 12 *W.*

The greater portion of this town is covered with heavy timber, the only noteworthy region of prairie being in the northwestern corner, covering secs. 6, 7 and 18, and parts of 19, 20, 17, 8 and 5. Mag. Var. 9° 42′ to 12°. Acreage, 23,035.51.

Beaver. *T.* 101 *N.*, *R.* 13 *W.*

A strip of timber accompanies the valley of Slough Creek, across the whole of this town, from section 6 to section 35, and the rest is of prairie, with several narrow sloughs, running generally north and south. Mag. Var. 8° 59′ to 11° 15′. Acreage, 23,072.50.

Bloomfield. *T.* 102 *N.*, *R.* 13 *W.*

There is an irregular area of timber and oak brush in the eastern and central part of this town, accompanying and spreading northward from the valley of the South Branch of Root river, but about two-thirds of the whole is of prairie, with a few sloughs in the eastern part. Mag. Var. 9° 8′ to 12°. Acreage, 23,013.96.

Spring Valley. *T.* 103 *N.*, *R.* 13 *W.*

There is a belt of prairie covering the southern tier of sections, including parts of 29, 28 and 27. The rest is sparsely or heavily timbered. Var. 10° 15′ to 13°. Acreage, 23,063.86.

Sumner. *T.* 104 *N.*, *R.* 13 *W.*

The southeastern part of this town is wooded, but more than one-half is of prairie, and flat. Mag. Var. 8° 25′ to 13° 15′. Acreage, 22,915.69.

Soil and Timber.

The soil of the county is generally very fertile. The immediate surface is a loam. This varies in color and composition, as well as in origin. That portion of the county covered with the northern drift has primarily a drift soil, which consists of gravelly clay. Where this forms the immediate surface, which is the case only on knolls and on the brows of the river bluffs, it affords a soil of an ashen color, if dry. In timbered belts it is more stony, or gravelly. In the open prairies, and in low grounds, it is covered with a loam. This is believed to have resulted from the natural decomposition of the coarse materials of the drift, under the calcining influence of the prairie fires, and the frosts of ages. It has never been seen stratified, or arranged with any regularity that would indicate its having been deposited either by standing or running water. In most cases, especially on the open prairie, it is nearly black. As it is mingled with the drift clay, it becomes lighter colored. In the low grounds it is much thicker, and also of a black color. Overlapping the drift area, in a belt about five miles wide, is a soil formed by the mingling of the loess loam with the drift. The loess loam is later than the glacial drift, and in the process of deposition it is modified by contact with the drift clay. The loess loam is indistinctly stratified, though it usually appears massive, and consists of fine, often clayey, sediment. The soil derived from it, usually sandy and light colored, or rusty, is sometimes so clayey as to make, when wet, a fine and very slippery mud. The soil derived distinctively from the loess loam covers at least one-half of the county, and is supposed to extend to the Mississippi river. It makes a rich and apparently a strong soil, as it supports a cropping of wheat from year to year. It is impossible to define its western limit. If it were derived from a long-standing inland lake, some beach lines would be found indicating its western boundary. No beach lines have been found. That it was deposited from standing water can hardly be questioned. It thins out westwardly gradually, passing through a confused or mixed condition, resulting from the mingling of the drift materials with the sediment, or by its overlapping the drift. While the essentially loess loam soil, of the eastern part of the county, can be distinguished easily from the drift soil of the western, no line of demarkation separating them has been noticed. A line drawn from the southeast corner of Bristol to the northeast corner of Jordan would roughly set off the area that has a distinctively loess loam soil. West of that is a belt five or six miles wide, in which the loess loam soil mingles with the drift soil. The rest of the county toward

the west is occupied with a distinctively drift soil, or drift loam soil.

The following list embraces such native trees and shrubs as were seen in the survey of the county. The trees are arranged in the estimated order of frequency. The area covered by native timber is steadily increasing:

Burr Oak. Quercus macrocarpa. *Michx.*

Red Oak. Quercus rubra. *L.* (?) [This is the oak that is abundant as underbrush, and small trees. It often forms thickets skirting the outlines of a prairie.]

Aspen. Populus tremuloides. *Michx.* [Generally small, and on the borders of prairies.]

White Oak. Quercus alba. *L.* [Common in the timber in Spring Valley and Jordan townships, and generally along the valleys of the principal streams.]

Wild Plum. Prunus Americana. *Marsh.*

Great-toothed Poplar. Populus grandidentata. *Michx.* [Very frequently mistaken for the American Aspen]

American Elm. Ulmus Americana. (*Pl. Clayt.*) *Willd.*

Bass. Tilia Americana. *L.*

White Ash. Fraxinus Americana. *L.*

American Crab. Pyrus coronaria. *L.* [Common along the margins of prairies and in open valleys.]

Iron Wood Ostrya Virginica. *Willd.*

Red Maple. Acer rubrum. *L.*

Sugar Maple. Acer saccharinum. *Wang.* [Common in the heavy timber in Spring Valley and Jordan township.]

Cottonwood. Populus monilifera. *Ait.*

Black Cherry. Prunus serotina. *Ehr.* [Trees generally small.]

Black Oak. Quercus tinctoria. *Bart.* (?) [Found in the heavy timber in the northwestern portion of the county.

Bitternut, Carya amara. *Nutt.*

Butternut. Juglans cinerea. *L.* [Seen most abundant in the heavy timber in the northwestern part of the county.]

Wild Red Cherry. Prunus Pennsylvanica *L.*

Thorn Apple. Crataegus coccinea. *L.*

Cockspur Thorn. Crataegus Crus-galli. *L.*

White Birch. Betula alba. Var. populifolia. *Spach.* (?) [Trees small; generally on stony soil, or along rocky river banks.]

Black Walnut. Juglans nigra. *L.* [In the heavy timber of the northwestern part of the county.]

Box Elder. Negundo aceroides. *Mœnch.*

Small Cedar. Juniperus Sabina, *L.* Var. procumbens, *Pursh.*(?) [Along the rocky river bluffs.]

White Pine. Pinus Strobus. *L.* An occasional large tree is seen along the river bluffs; but the most of it, suitable for lumber, has been cut.

Water Beech. Carpinus Americana. *Michx.*

Shag-bark Hickory. Carya alba. *Nutt.* [Seen in the valley of Root river, and in the tributary gorges at Rushford.]
Smooth Sumac. Rhus glabra. *L.*
Cornel. Cornus paniculata. *L'Her.*
Cornel. Cornus circinata. *L'Her.*
Wolfberry. Symphoricarpus occidentalis. *R. Br.*
American Woodbine. Lonicera grata. *Ait.*
Juneberry. Amelanchier Canadensis. *Torr. and Gray.*
Hazelnut. Corylus Americana. *Walt.*
High Blackberry. Rubus villosus. *Ait.*
Red Rasperry. Rubus strigosus. *Michx.*
Black Raspberry. Rubus occidentalis. *L.*
Dwarf Wild Rose. Rosa lucida. *Ehr.*
Pipe Vine. Aristolochia Sipho. *L'Her.* (?)
Grape. Vitis cordifolia. *Michx.*
Virginia Creeper. Ampelopsis quinquefolia. *Michx.*
Nine Bark. Spiraea opulifolia. *L.*
Sheep-berry. Viburnum Lentago, *L.*
Staghorn Sumac. Rhus typhina. *L.* (Rare.)
Bittersweet. Celastrus scandens. *L.*
Rose. Rosa blanda. *Ait.*

The Geological Structure.

The rocks of the county belong to the Devonian and to the Upper and Lower Silurian ages. The Cretaceous also appears in Sumner township, in the extreme northwestern corner of the county. They occur as arranged in the following order, with their approximate thicknesses:

1. Cretaceous. Thickness unknown, perhaps 100 feet, lying unconformably on the older rocks.
2. Upper Devonian. Hamilton.
3. Lower Devonian. Corniferous.(?) } ..... 100 feet.?
4. Niagara of the Upper Silurian ..... 200–250 feet.
5. Maquoketa (Cincinnati) of the Lower Silurian ..... *75–100 feet.
6. Galena, of the Lower Silurian ..... 75–100 feet.
7. Trenton, of the Lower Silurian ..... 160 feet.
8. St. Peter, of the Lower Silurian ..... 122 feet.
9. Shakopee,
10. Jordan, } Lower Magnesian of the Lower Silurian, { 75 feet. / 25–40 feet. / 200 feet.
11. St. Lawrence,
12. St. Croix, of the Lower Silurian, exposed ..... 375 feet.

With the exception of the Cretaceous these formations have a *strike* across the county northwest and southeast. They have a

* Geology of Wisconsin, Vol. 1, p. 181.

gentle dip, at least theoretically, toward the southwest, though no general dip is perceptible. The oldest rock in the county is the St. Croix sandstone, which appears in the northeastern corner of the county. The latest, except the Cretaceous, is the Devonian, in the southwestern part of the county. The areas of outcrop are shown by the colored map of the county accompanying this report. The boundary between the Trenton and the St. Peter is the most accurately defined, owing to the terrace which marks it. The boundary between the St. Peter and Shakopee it is impossible to ascertain certainly, because of the universality of the loam, which acts, in that respect, just the same as a heavy drift deposit, and also because of the persistency of the Shakopee compared to that of the St. Peter. When the friable rock is below a hard and persistent one, as the St. Peter below the Trenton, the boundary between them can be traced out easily by the resulting topography; but when the soft one is uppermost it wedges out imperceptibly under the loam, or drift, and one cannot say when it is all gone. In the western part of the county the boundary lines are all obscured by the prevalence of the drift. The Maquoketa shales have not been seen in the county. They are visible in the bluffs of the Upper Iowa River, at Lime Springs, about three miles south of the State line, and very probably continue through Fillmore county, in the strike of the Lower Silurian.

The St. Croix Sandstone.

The area of the St. Croix sandstone is small. It only occupies the lower portion of the river bluffs, and the bottom land included between them, from the county line, near Rushford, to near Lanesboro. This bottom land is sometimes two miles, or more, in width, but it is an alluvial deposit, and never reveals the rock. The only visible outcrops are in the slopes of the bluffs. This sandstone also enters the county, in a similar manner, in the valley of the South Branch of Root river, and extends about three miles west of the county line.

Its *general lithological character* is all that can be learned of this rock from its exposures in Fillmore county. The opportunity for examination is very unfavorable. The bluffs, over the interval occupied by it, are almost universally turfed, and a heavy talus rises nearly or quite to the lower level of the St. Lawrence limestone. It is in general a light colored sandstone, with alternations of limestone, and some shale, in its upper portions. The sandstone layers

crumble easily. Some of the beds are of a very coarse grain, but the quartz is generally white, almost transparent. The limestone layers are like that of the St. Lawrence, and contain a few fossils, none of which have been studied yet with care sufficient for reliable specific identification. At Whalen, about 95 feet of the St. Croix sandstone are included in the lower slopes of the bluffs. This thickness of bedding disappears below the river level before reaching Lanesboro. At Rushford, the sandstone, and talus which is supposed to consist mainly of sandstone, rise 375 feet above the river. Near the upper portion of the sandstone, a conspicuous terrace or line of frequent exposure, producing a shoulder, may be seen along the creek in entering Rushford from the south.

The St. Lawrence Limestone.

This is the lowest portion of the *Lower Magnesian* formation of Dr. D. D. Owen. In the annual report for 1873, the geology of the Minnesota Valley is given. It is there announced that the great formation to which the name *Lower Magnesian* has been applied, consists of three distinct members—two limestones separated by a sandstone—and the names of the localities where these members have their characteristic outcrops, in that valley, were applied to distinguish them, as they will play an important part in working out the detailed geology of the eastern portion of the state. Since the publication of that report, a similar subdivision of the Lower Magnesian has been discovered in the state of Wisconsin, and it is announced in the American Journal of Science and Arts, for June, 1875, by Prof. R. Irving, of the University of Wisconsin. The county of Fillmore lies intermediate between the two points at which this similar alternation of parts in the Lower Magnesian has been identified, and may throw some light on the question of the parallelism of these principal members. Fillmore county is separated from the Mississippi river by one county, Houston, which is 24 miles in width, east and west, and borders on the state of Iowa.

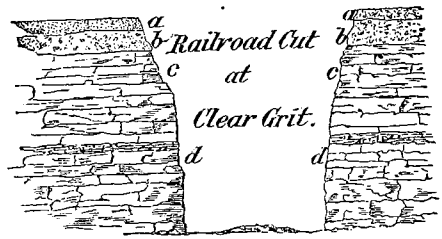
The *area* of this limestone is embraced in that which is, in general, assigned to the Lower Magnesian on the accompanying map. Along the river bluffs, nearly to Rushford, it is found only in the lower portion of the limestone belt, as the Jordan sandstone and Shakopee limestone are both preserved, and overlie it; but toward Rushford this limestone begins to be the only one that is found in the bluffs, the other members of the lower Magnesian having a strike across the country some miles in either direction away from the immediate valley. There are places, even further east still,

where the overlying Jordan and Shakopee are preserved and appear in the tops of the river bluffs. The St. Lawrence extends in the bluffs of the Root river to some distance above Isinours' Station, and nearly to the lower mill at Preston. The valley of Watson's creek at Isinours' Station is cut about 25 feet into the St. Lawrence. At Lanesboro the amount of the St. Lawrence visible is about 195 feet. At Whalen 155 feet are seen in the upper portion of Whalen's bluff. At Rushford the uppermost 190 feet of the bluffs are of the St. Lawrence. The thickness of the formation is not far from 200 feet. It constitutes the principal portion of the Lower Magnesian.

The St. Lawrence, in Fillmore county, is a *dolomitic limestone*, with some of its layers distinctly arenaceous, and stained with green sand. In general, its bedding is regular and evident, but there is a thickness of about 15 feet near the bottom of the formation in which the bedding is confused, or the layers are lost horizontally. Below this confused bedding are, however, about 25 feet of regular beds, which have a fine even grain, and though not plainly arenaceous, yet have a very fine grit. On fresh surfaces it is of a buff color, varying to cream color. The upper portion abounds in patches of white calcite. There are also in the upper portion spots that show thin, concentric, though wavy, laminations, as if from concretionary forces, or the result of silicified masses of *foraminifers*, reminding the observer of the laminated masses of limestone from the *Laurentian* containing the *Eozoon Canadense* of Dr. Dawson. Though the most of the rock of this formation is vesicular, often coarsely so, it is much used for building, for which it furnishes both large blocks for the heaviest masonry, and fine-grained stone that can be cut into delicate forms. When cut for window caps or sills the cut surfaces are nearly white. The bedding varies in thickness from two or three inches to two or three feet, and sometimes embraces thin beds of shaly, light-colored, fine-grained rock that is useless for all purposes.

At Clear Grit Mills, in the valley of Root river, the St. Lawrence begins to show a continious line of bare rock, in the river bluffs, running along the lower slopes, and causes a shoulder or terrace in the general descent. A quarry near the mill-dam shows about 15 feet of even layers. Above these are the layers represented in the railroad cut near that place. These are light-colored, dolomitic, vesicular, abounding in patches of calcite with some chert, and siliceous concretions, the latter sometimes covered with limonite pseudomorphous after pyrite. The annexed profile exhibits the cut and the materials exposed.

Fig 2.



a.—Loess Loam, 8 feet, red.
b.—Drift Gravel, 4 feet, red.
c. Jordan Sandstone, 16 feet, red.
d. St Lawrence Limestone, 30 feet.

At Whalen the St. Lawrence is finely exposed in the bluff that stands in the valley about half a mile below the village. It has here been considerably quarried, and furnishes a very good stone for buildings. It lies in even layers, which are easily broken into desirable size and shape, furnishing a good cut-stone of close grain, without openings. Of the 155 feet that here overlie the St. Croix sandstone, only the lower portion is well exposed. The exposed layers are separated from those seen at the quarry at Clear Grit by an interval of 50 feet. They consist of the following parts, aggregating 60 feet:

1. Slope, hid by turf, (St. Lawrence)..... 95 feet.
2. Heavy beds, even-grained, vesicular, the best general building stone..... 20 feet.
3. Bedding confused, not evident, lenticular..... 15 feet.
4. Fine grit, regular beds, dolomitic..... 20 feet
5. Hard arenaceous, projecting, fossiliferous with the remains of trilobites..... 5 feet.

At Lanesboro the St. Lawrence has been used in the construction of the principal buildings. The quarries are owned by the Lanesboro Company. The stone presents the usual characters, but has associated masses of pyrite, largely converted to limonite, showing octahedral forms of crystals, with combinations. In some of the cherty nodules, are found small orthorhombic crystals of hydrated iron peroxide, formed by the conversion of marcasite into limonite. This iron ore is quite plentiful, but seems not to be a native of the rock. It embraces crag and bog-ore deposits, and is referable to the drift period. (See under *drift.*)

The Jordan Sandstone.

This sandstone, lying next above the St. Lawrence limestone, is not so frequently seen along the river bluffs. It is most commonly embraced in that interval of slope that comes between the two lines of limestone outcrop, and which is mostly turfed over, as in the bluffs at Lanesboro, and at points between Preston and Lanesboro. Further down the river, where the strike of the Shakopee runs back from the river a few miles on either side of the valley, it occupies the undulating surface between the immediate river bluffs and the boundary of the Shakopee, as at Rushford. This sandstone, in the Minnesota valley, has been mistaken for the Potsdam, the overlying Shakopee being supposed to be the lower portion of the lower Magnesian. (*Owen's Geological Survey of Wisconsin, Iowa, and Minnesota*, pp. 481–495. See, also, Prof. James Hall's "*Notes on the Geology of some portions of Minnesota, from St. Paul to the Western part of the State*," 1865.)

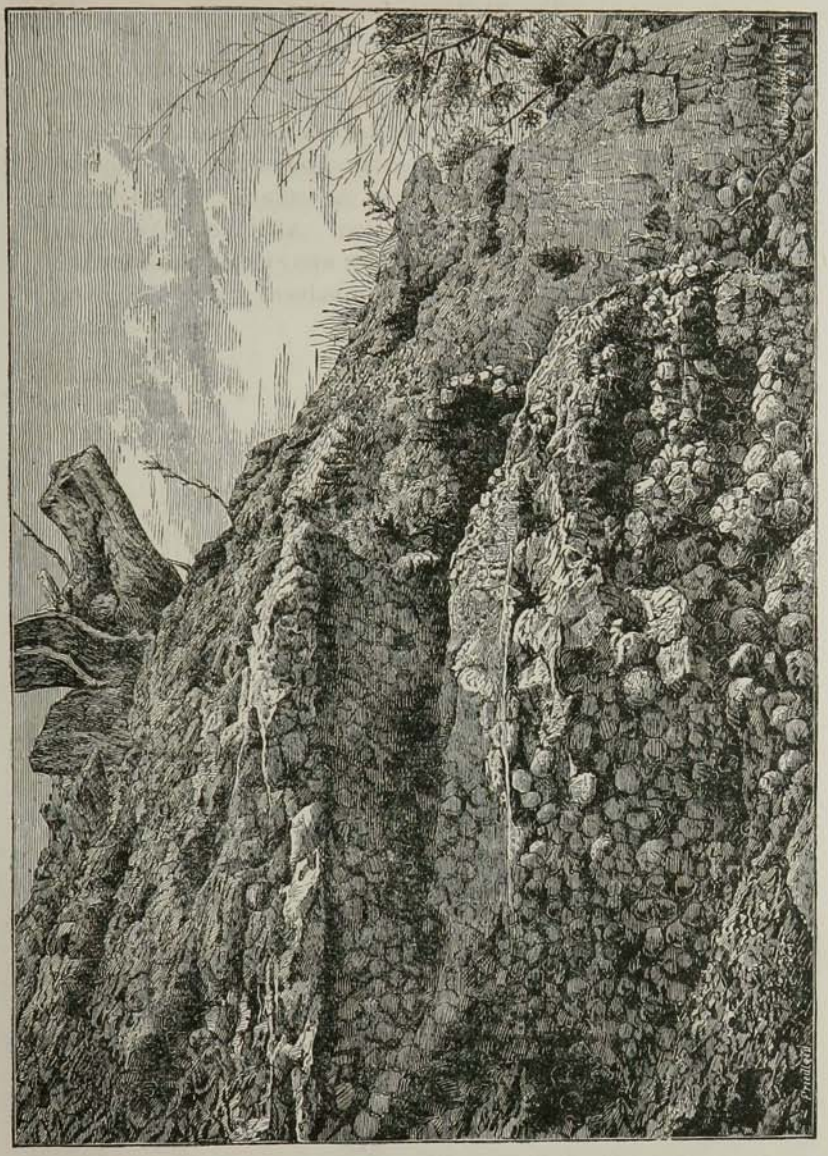
In Fillmore county the thickness of the Jordan is not so great as it is in the Minnesota valley. It seems to vary from 25 feet to 40 feet. At Mankato, in Blue Earth county, it is fully fifty feet thick. It is uniformly a coarse grained, quartzose, crumbling and light colored sandstone. It is sometimes locally stained with iron from surface water, when it presents a reddish or rusty color, and is apt to be much harder. It has in such cases a shell or thin coating of harder rock, about half an inch in thickness, on the weathered surfaces, on penetrating which the grains are loosely cemented, and even crumbling. In other places, it presents internally a streaked appearance, due to the stoppage of iron filtering through its strata. No fossils have been found in it.

One of the best exposures for examining this sandstone may be seen at Preston, where it rises 25 feet above the level of the river opposite the stone mill, and is surmounted by about 35 feet of the Shakopee limestone. The bluff itself rises about 95 feet above the river, but the contents of the upper portion, though probably of the Shakopee, are not certainly known. The loam covers it. The bedding of the stone here is regular, though in some places a little wavy, and is of all thicknesses, from a foot to three or four inches.

At Lanesboro the Jordan exhibits, near the top, a finely concretionary structure. The balls vary from a few inches to nearly a foot in diameter. Some of them are elongated, and several are frequently united. The rock itself is generably friable, and crumbles out, leaving the concretionary shapes visible. They are often

loosened, and roll down the bluff. They lie in approximate layers for a thickness of four or five feet. Some of them are pendant from the projecting shelf, and stud the whole under surface. They are generally spherical, but when they are lengthened perpendicularly, they show the original lamination that ran through the rock, in the form of rings and furrows. The accompanying view, engraved from a photograph by Andrew Ellickson, of Lanesboro, gives an imperfect representation of this portion of the bluff. This view was taken near the mill dam, above the railroad cut.

FIG. 3.



Concretions in the Jordan Sandstone at Lanesboro.

At Clear Grit the Jordan is 25 feet thick, and is exceedingly ferruginous. At Lanesboro it is about 40 feet thick.

The Shakopee Limestone.

This is the uppermost member of the Lower Magnesian, and is so named from the village of Shakopee, in Scott county, on the Minnesota river, where it was first identified as a distinct and entire member of the great Lower Magnesian Formation. In Fillmore county it is more frequently seen along the valley of Root river and its tributaries than any other formation. As it lies between two sandstones, each of which easily crumbles away under the operations of the elements, it is made to have a prominent position in giving form to valleys and river bluffs. The North Branch of Root river enters on it about six miles northwest of Chatfield, in Olmsted county; the Middle Branch near the town line between Chatfield and Jordan, and the South Branch but a short distance below Forestville. South Root river strikes it near Henry, in Amherst township. Thus, throughout about two-thirds of the county, it is the constant companion of the traveler along the river valleys, and it meets him often in the uplands, and in the valleys of little creeks. Its effect on the topography is to render the valleys narrow, rocky and abrupt. Within the general area of the St. Peter sandstone and the Trenton limestone, it produces a shoulder in the descent from the uplands to the valley. The following diagram, taken at Chatfield on the northern boundary of the county, illustrates in general the effect of this limestone in producing a terrace along the lower slopes of the river bluffs, within the general Trenton area.

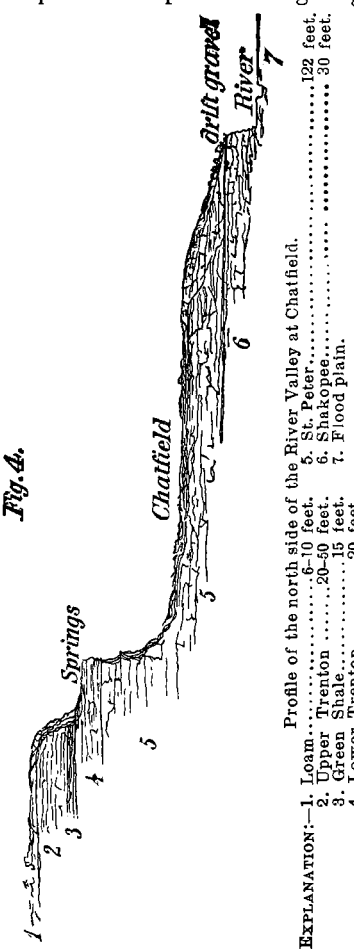


Fig. 4. Profile of the north side of the River Valley at Chatfield.

Explanation:—1. Loam.....6–10 feet. 5. St. Peter.....122 feet.
2. Upper Trenton .....20–50 feet. 6. Shakopee..... 30 feet.
3. Green Shale.....15 feet. 7. Flood plain.
4. Lower Trenton.....20 feet.

The descent from the general

level of the country at Chatfield (No. 1) to the river (No. 7) is about 222 feet, of which about 30 feet are of the Shakopee, the descent from the Shakopee to the river being at the river. The broad terrace on which Chatfield stands is constituted of the Shakopee overlain by irregular thicknesses of the St. Peter, with some drift and loam. The lithology of the Shakopee is very much the same in Fillmore county as it has been described in former reports at Mankato and Shakopee, in the Minnesota Valley. It is very similar to the St. Lawrence, with much less of green sand. It contains at Chatfield considerable disseminated sand, and nodules of calcite. The calcite is sometimes purely transparent, so as to exhibit the double refraction of Iceland spar, parting into large rhombohedrons, but the most of it is opaque. It is sometimes interspersed with sand grains taken up in the process of crystallization. These are so abundant as to make, of some crystalline masses, a sandstone which is then nodular and hard, with warty projections.

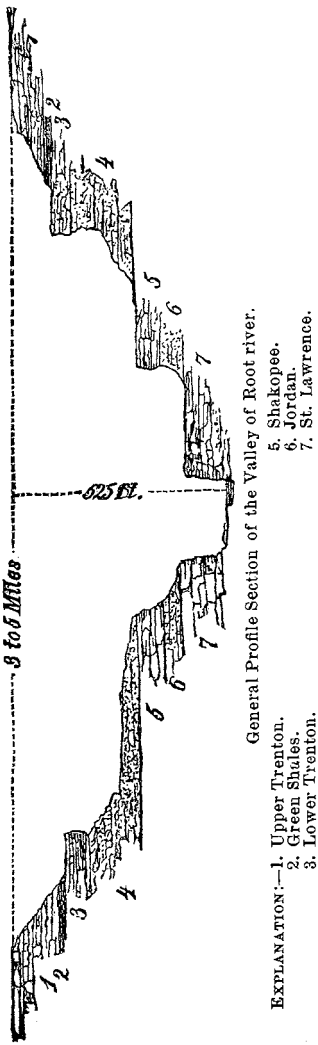


FIG. 5.

General Profile Section of the Valley of Root river.

EXPLANATION:—1. Upper Trenton.
2. Green Shales.
3. Lower Trenton.
4. St. Peter.
5. Shakopee.
6. Jordan.
7. St. Lawrence.

At Parsley's Ford, centre of section 15, Chatfield, a bridge is being built over the river, the abutments being of the Shakopee stone taken out near the ford, on Mrs. Doyle's land. At the ford the river is on the Jordan sandstone. There has been considerable stone cut off the bluffs, in the Shakopee, for use in the railroad bridge near the same place, and laid up in heavy blocks; but much of the Shakopee is in irregular and thin layers, unfit for such use.

At almost any point east of Chatfield and Carimona, the Shakopee can be seen by one crossing the valley of Root river, exhibiting its

peculiar tendency to narrow the valley, and forming a conspicuous bench or shoulder. The following diagram of a general profile section of the valley, illustrates its form at points between Preston and Lanesboro; also between Chatfield and Lanesboro, along the North Branch. At Preston the rocks show a dip to the south.

At Isinours' Station the battlements of rock that enclose the valley, rising about 30 feet above the water, are of the Shakopee. There is an undulating ascent thence over the St. Peter to near the Trenton terrace, which rises nearly perpendicular about 50 feet. Beyond this is a flat, running sometimes but 8 or 10 rods, but not infrequently a quarter of a mile, when a further gradual ascent begins, covering the Green Shales and the Upper Trenton. This last ascent, with the loam that here covers the country, generally makes about 175 feet.

At Carimona, the Shakopee is visible in the banks of the river, rising 25 or 30 feet. Its average thickness is about 75 feet.

The St. Peter Sandstone.

The thickness of this well-known formation in Fillmore county does not vary much from its reported thickness in the central portion of the state. It has been taken at 125 feet. At Chatfield, it measures, by aneroid, 122 feet. In lithological characters it is also the same, consisting of clean white sand that easily crumbles. Near Fountain, an exposed section near the top of the formation, afforded fragments of an unknown species of *Lingulepis*, the first and only fossil of any kind that has ever been found in this rock. The following section was taken at this place. It includes the overlying lower Trenton, and the green shales, as seen at the quarry of Mr. Joseph Taylor, section 13, Fountain.

Section Near Fountain—Quarry of Joseph Taylor.

No. 1. Green shale, mixed with fragments of limestone that are eminently fossiliferous.....seen 3 feet.

No. 2. Limestone, of a bluish-gray color, in beds from four to six inches thick, free from shale, though the layers are sometimes thinly separated by shaly partings..... 10 feet.

No. 3. Arenaceous and ferruginous shale, alternating horizontally with firmly cemented patches of sandstone..... 2 feet.

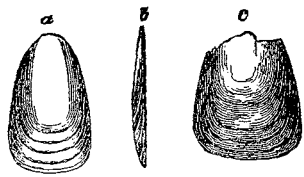
No. 4. Massive, coarse sand; white, except where iron stained, containing irony quartzite pebbles, and fragile remains of bivalves..... 6 feet.

No. 5. Green shale, with some arenaceous and calcareous laminations..... 3 feet.
No. 6. Cemented sandstone, the cement being shale and lime, forming when the bluff is weathered, the floor of a bench 1 foot.
No. 7. White sand, in beds that are about one foot thick, and horizontal..... 6 feet.
No. 8. A course in the sandstone more firmly cemented, forming another table, but less persistent than No. 6..... 1 foot.
No. 8. Massive sandstone, in some places showing an oblique lamination.....seen 6 feet.

The Southern Minnesota railroad here enters on its descent to the Root river valley.

The species of *Lingulepis* mentioned is found in No. 4 of the foregoing section. The remains are exceedingly fragile, and as the grains of sand in which they are embraced are feebly cemented together, it is nearly impossible to transport, or even to handle them without their falling to pieces. These fragments, for no entire specimens were obtained, are arranged promiscuously in the coarse sand, and are all confined within three feet of the top of No. 4. They seem to have suffered the attrition and friction incident to coarse sedimentary transportation. They dispel the idea, which has been suggested, of the possible chemical origin of the St. Peter sandstone, as an oceanic precipitate.

FIG. 6.



Lingulepis Morsensis. (N. sp.) Natural size.

Description.—Shell conical or elongate-conical, with anterior angles rounded; depressed; the apical angle not seen perfect; the front margin gently convex; sides nearly straight, but converging at an angle of about 26 degrees; greatest width is near the front and at a distance from the anterior margin of one-third the greatest width. The surface is smooth and shining, marked with very fine concentric striæ, visible especially in the anterior portion, and with more distant, dim undulations of growth. Entire length of the larger specimen seen (Fig. c.) about .85 inch; width .52 inch; length of the smaller (Fig. b.) .78 inch, width .45 inch. Color of the shell

light brown, with spots of brown. The smaller specimen has flattened, or slightly concave margins, for nearly two-thirds the length from the apex. This species in general contour resembles *Lingulepis Briseis*, of Billings, (Palæozoic Fossils, Vol. 1, p. 48,) but differs from it in not having its sides parallel.

Locality and Formation—Near Fountain, Fillmore county. Upper portion of the St. Peter sandstone. Named in honor of Prof. E. S. Morse.

The remarks that have already been made on the topography of the county, and the diagrams that have been given, will sufficiently elucidate the nature of the St. Peter, and its important part in the causes that have diversified the surface of Fillmore county.

The Trenton Limestone.

This formation is the most important one of the county, both on account of the great superficial area it embraces, and because it appears in numerous places under the most favorable circumstances for working for quicklime and for building stone. It is likewise the most conspicuous of all the formations, especially along the line of its strike, where it gives way, and the surface falls rather suddenly on to the lower level of the St. Peter sandstone.

The term *Trenton limestone* is here made to cover a thickness of rock of about 160 feet, and to embrace, within the limits of Fillmore county at least, three distinct members, of which the uppermost is the principal portion.

Upper Trenton limestone	125 feet.
Green shale	15 feet.
Lower Trenton limestone	20 feet.

The transition from the St. Peter sandstone to the lower Trenton is quite abrupt. There is no commingling of qualities from the Trenton downward into the St. Peter, although a shaly layer of about two feet separates them. The limestone always projects boldly beyond the sandstone, and the sandstone becomes immediately white and friable, with a very slight calcareous cement. The lower Trenton plays the most important part in producing the marked topographical characters of the central portions of Fillmore county, since, by its superposition over the crumbling St. Peter, it constitutes the edge of the shoulder or terrace that marks their line of superposition, and not unfrequently spreads out on the top

of an isolated table or mound, thinly overlain by the lower layers of the green shale. Under the head of *Surface Features*, this point has been mentioned already, and the reader is referred to that section.

In Fillmore county, the lower Trenton, known sometimes as the "Buff limestone," which corresponds in horizontality with the limestone quarried at St. Paul and Minneapolis, is much less affected by disseminated shale than in those cities, and hence makes a much more desirable building stone. The color is light blue, and in quarrying the layers rarely exceed five inches in thickness. On weathered bluffs, the bedding appears even thinner than that, being apparently not more than two inches. When these layers are opened and considerably quarried they combine, and produce layers that are from four to six inches in thickness. They are generally tough and hard, though when broken they often fracture conchoidally, and in unexpected directions. The fossils they hold are undergoing careful examination. The most striking are species of *Orthoceras*, often regarded by the quarrymen as the remains of huge snakes, though really oceanic shell-fishes, and a beautiful species of *Lingulepis*.

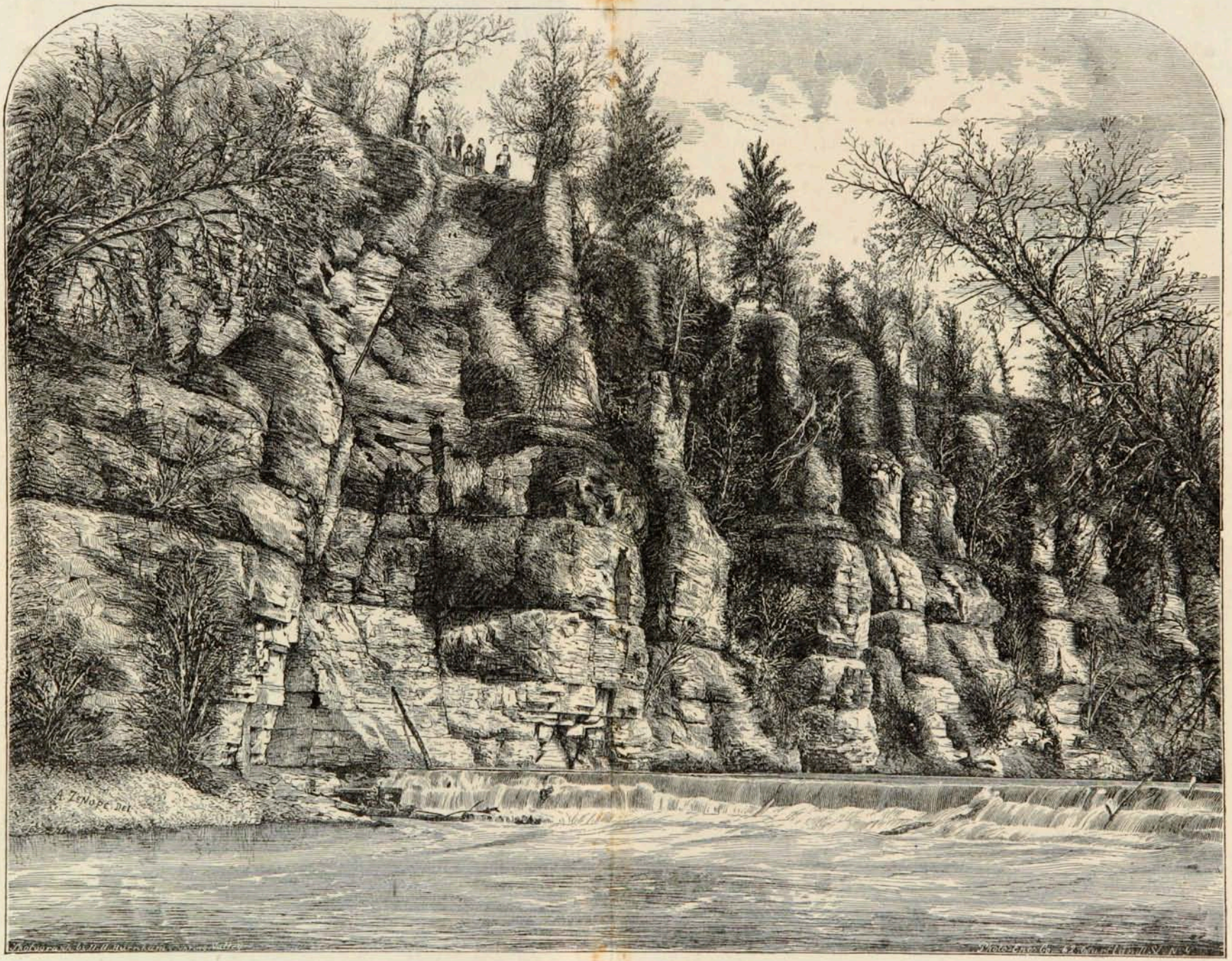
The interval covered by the *green shale* (15 feet) is not often seen well exposed. The uppermost layers have not been seen at all in Fillmore county, but the lower layers are visible in many places where the lower Trenton is quarried. When wet constantly this shale becomes a plastic clay. Along the brow of the Trenton terrace it colors the earth in nearly all roadways that cross it, and produces, by shedding the surface water, very muddy spots, in which teams are sometimes mired. One remarkable spot of this kind is near the top of the bluff a mile and a half west from Chatfield, S. W. ¼ sec. 1, Jordan. This shale always lies in thin layers, and sometimes embraces continuous beds of blue limestone which are exceedingly fossiliferous. It also sometimes holds fragments of limestone, of the same kind, in the form of slabs. A great many fragments of *Chaetetes Lycoperdon* accompany this shale and roll down the face of the weathered slope, besides crinoidal fragments and species of *Orthis*, *Leptaena* and *Strophomena*.

The Upper Trenton, sometimes known as the Blue limestone in the northwest, which is about 125 feet thick, consists of a bluish or grayish, evenly bedded limerock, varying from fine-grained and compact, in layers of a few inches, to more vesicular, sometimes arenaceous, and in beds of one to two feet. It contains but little shale in Fillmore county—and that is near the base and near the

top. This rock forms a great many precipitous bluffs. It appears in the form of mural faces along a great many creeks and canons in the central portion of the county. It generally rises nearly perpendicularly from the top of a short talus to the summit, exhibiting a continuous section of the bedding. Its area is pre-eminently the region of sink holes. The canons that are so frequent in it run out in ascending the valleys, and disappear in a succession of sink holes which become smaller and smaller, and more and more distant, till the general praire level is reached. While in general the lithological characters of this part of the Trenton are quite uniform, near the top the layers begin to alternate with layers that exhibit the characteristic lithology of the Galena, and are accompanied with some thin layers of green shale. It seems to pass gradually into the Galena, or rather to assume the features that have been ascribed to that formation.

The following views represent the manner of weathering of the Upper Trenton. At Weisbeck's Dam, on Deer Creek, S. E. ¼ sec. 11, Spring Valley, the face of the bluff, which rises perpendicularly about a hundred feet, is wrought into a series of majestic pilasters running from the bottom to the top of the escarpment. The view here given is from a photograph by D. D. Burnham, of Spring Valley, engraved by the *Photo. Engraving Company*, 62 Courtlandt Street, New York.

FIG. 7



VIEW OF THE UPPER TRENTON AT WEISBECK'S DAM. SEC. 11, SPRING VALLEY.

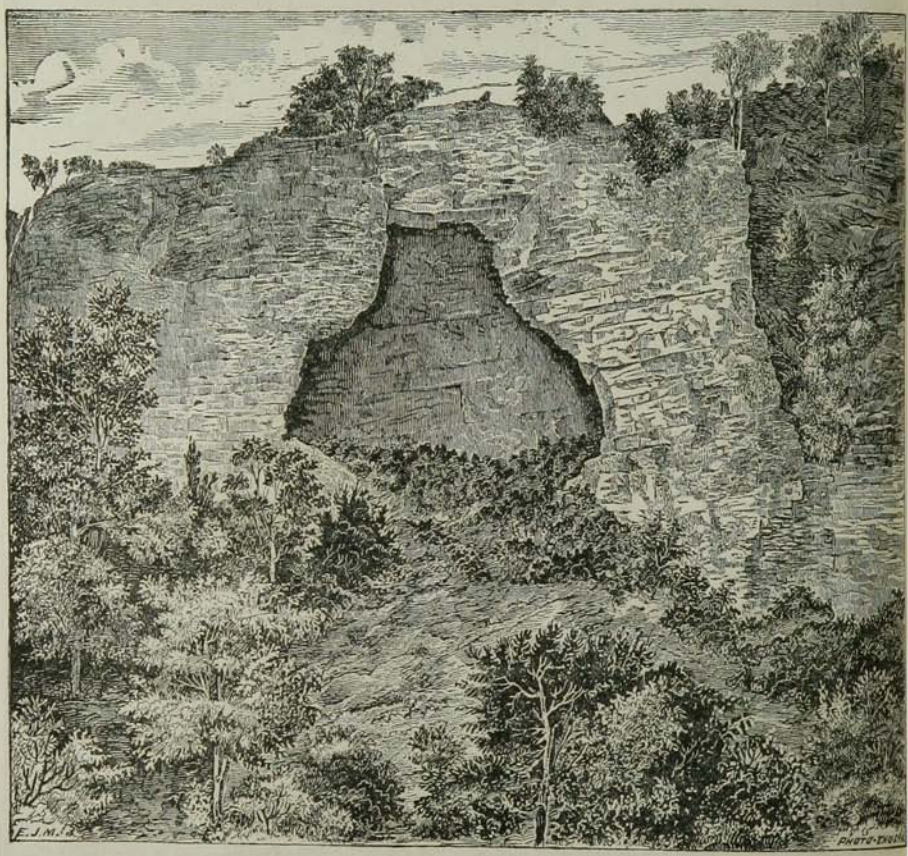
The weathering and erosion of the Upper Trenton have left many scenes of picturesque beauty in the county, some of which have been photographed by Mr. Burnham. The following are some of the most noteworthy. Figure 8 shows the Eagle Rocks situated in the valley of the South Branch of Root River, on section 27, Forestville. They stand isolated in the valley, but do not rise higher than the common rocky walls of the valley.

FIG. 8.

Eagle Rocks—Trenton Limestone, Sec. 27, Forestville.

Figure 9, Chimney Rock, is a view on the side of the bluff of a ravine, tributary to the south branch of Root River, on section 27, Forestville. A crevice, originally due probably to a plane of jointage, enters the rock at a small angle with the face of the bluff, and has been widened by frost and water till it will admit a man. The detached, wedge-shaped mass, has been broken through near the foot of the bluff, and by the falling out of repeated fragments an opening having a fancied resemblance to an oven with a low chimney, has resulted.

Fig. 9.



Chimney Rock—Trenton Limestone, Section 27, Forestville.

The following details concerning the Trenton limestone will further elucidate this formation as it appears at various places in the county.

Southeast quarter section 23, Spring Valley, quarry of John Kleckler. The rock here is a gray limestone, with interlaminations of shale. This is very different from the Galena, as seen at Spring Valley village. It is compact, and, with the exception of the thin laminae of shale, consists entirely of limestone. Exposed about 10 feet.

Southeast quarter section 23, Spring Valley, Joseph Lester has a quarry in the valley of the Middle Branch, very similar to Kleckler's. That of Henry Prosser occurs on southeast quarter of section fourteen.

North part of section 25, Spring Valley. At Mr. H. Perkins' saw-mill the same rock is visible, and has been wrought. From this point the banks of this creek become continuously rocky.

G. W. Knight's quarry is near Fillmore, section 10. The stone is hard, gray, compact, brittle and fossiliferous, in beds of all thicknesses, depending on the weathering and exposure, up to eight or more inches. It is situated along the ravine, approaching Fillmore.

Geo. Shepherd's quarry is also near Fillmore, on northeast quarter of section 9, and seems to consist mostly of isolated even layers in the shale that so frequently accompanies the Trenton. In this shale are *Chaetetes*, *Rhynchonella*, and *Strophomena*. The stone is not of much account, owing to its being encumbered so heavily with the shale, but is very desirable for the uniformity of its thickness. S. C. Pettit has a quarry of the same kind on northeast quarter of section 10.

At Chatfield, the lower Trenton appears in the highest bluffs on the north side of the village. It is made up very largely of shale, but affords also some even layers, that are wrought. These have the same stratigraphical horizon as the stone at Minneapolis and St. Paul, but do not contain so much argillaceous matter. They are much firmer and more compact, though not so thick in the aggregate. Below these layers the St. Peter sandstone is seen. The Trenton at this point has a gentle dip northeast, while the Shakopee at the mill by the river dips northwest. The brachiopod *Leptaena deltoidea*, so common at the Falls of St. Anthony, is here seen in great numbers, and an occasional specimen of *Lingulepis quadrata*. The section at the quarry of Dennis Jacob is made up of seven feet of limestone and shale, crumbling away, underlain by about eight feet of limestone.

Extensive working and burning of the upper Trenton into quicklime is carried on along Bear and Deer creeks, the banks of which are continuously rocky, rising perpendicularly from one to two hundred feet from the water, in Sumner and Spring Valley townships. These quarries are described under the head of *Economical Geology.*

Sometimes the Trenton shows, on freshly opened quarries, along the bluffs, almost a white color. This is particularly the case on north half of section 35, Sumner, where an opening in a long-weathered "hog's back" reveals a very light-colored limestone, in beds of about three inches, of a fine grain and compact texture; not much crystalline, and evidently impure with argillaceous and siliceous qualities.

The quarry of Mr. Joseph Taylor, section 13, Fountain, has been mentioned already under the head of the St. Peter sandstone, and the exposed section given. At this quarry very large cephalopods have been taken out, and some fragments of galena have been encountered, though the opening is in the lower Trenton.

The quarry of Mr. Enoch Winslow is on the same horizon as Mr. Taylor's. It is situated on the bank of Sugar Creek, S. W. ¼ sec. 4, Fountain. Another on the same horizon is that of John Johnson, 2 miles south of Fountain. The Trenton is also wrought at Forestville and near Carmiona, presenting no exceptional features. At Forestville it contains *Receptaculites* and *Strophomena*, and exposes a thickness of about 140 feet.

The Upper Trenton appears S. E. ¼ sec. 6, Forestville, along a little ravine, and is slightly opened by John Hipes. It also appears at other points between there and Spring Valley.

At Baldwins' Dam, sec. 21, Forestville, 130 feet of the Trenton are seen. No Galena visible, and no Green Shale.

S. E. ¼ sec. 30, Forestville. In some fragments thrown out in the digging of a well, can be seen a fine grained rock, resembling the fine shale seen in the race at De For's mill, which crumbles to pieces in the weather. It here lies below some heavy Galena beds, seen in the hills enclosing the valley, and contains doubtfully species of *Graptolites*, *Orthis*, and *Orthonota.*

At Granger, the Trenton only occupies the bluffs; but at two miles west of Granger, where the river enters the state for a short distance, the bluffs are high, and are made up of the Trenton, with a topping of fifteen or twenty feet of Galena.

Northwest quarter of section 36, Bristol. Hiram Andrews has a quarry in the Trenton, which alone occupies, at this place, the river banks, though the beds of the quarry are apparently in the upper

portion of the formation. The layers are thicker than usual, somewhat vesicular, and present some of the aspects of the Galena. The rock shows a slight dip to the south. Mr. Andrews has built a stone barn and stable.

The Galena Limestone.

The only separating horizon between the Trenton and Galena limestones is a lithological change in the rock. There is no unconformability between the layers of the formations, and there is no known difference of fossil contents. Near the upper portion of the Trenton occasional layers appear that are much more porous, and have a light buff color. They are also much heavier than the layers of the Trenton, reaching, after the change is fully established, a thickness of four or five feet. Mingled with these heavy magnesian layers are thinner layers of green shale. When these heavy magnesian beds are near the top of a bluff, they give it a roughness, but at the same time a persistence of outline which the thinner beds of the Trenton alone do not possess. This rock is generally sharply crystalline. It contains numerous cavities of irregular shape, some due to the weathering out of carious material, and some to the absorption of fossils It holds considerable masses of calcite, and sometimes lumps of galena, from which it has derived its name. Although the Galena limestone, near Dubuque, in Iowa, is stated by Prof. J. D. Whitney to be about 250 feet, (Geology of Wisconsin, vol. I, 172,) it enters Minnesota with a thickness much less than that. From all that can be seen of it in Fillmore county, it appears to be less than 100 feet thick. The Trenton, on the other hand, is given, by the same authority, at 70 feet average thickness, at Dubuque, while it has a thickness of 160 feet in Fillmore county.

The characters that distinguish the Galena are not constant. In Fillmore county the "lead fossil," *Receptaculites*, pervades the Trenton as low as the green shale, at least—although regarded as characteristic of the Galena; and the *Lingula quadrata*, also said by Prof. Whitney to not appear in the lead region, in the "blue" nor the "buff," is found throughout both. A very fine specimen was obtained, of the latter, at Mr. Taylor's quarry, near Fountain, from the lower Trenton, ("buff limestone" of Prof. Whitney,) and another from Chatfield, from the same horizon. Lithologically also the two formations appear to merge into one another. The compact, hard blue limestone, characteristic of the Trenton, gives place near the top of that formation, to a lighter colored, slightly vesicular, even grained, more heavily bedded rock, that is very useful for an orna-

mental cut-stone. This is seen in some of the quarries a mile or two east of Spring Valley, where it is difficult to assign the beds either to the Galena or to the Trenton. A short distance further east the well characterized Trenton appears, while at the village of Spring Valley, unmistakable Galena features pervade the rock exposed, to the depth of ten or twenty feet. The lead ore, moreover, which has given name to the Galena, is not confined to that formation. It is found to some extent both in the Galena and the Trenton, though in neither to that extent that will warrant sanguine expectations.

The Galena, where not hid by the Cretaceous in the northwestern part of the county, is within the drift area. Hence it has not been so fully observed as is desirable. The line separating its superficial area from that of the Trenton is defined with tolerable accuracy on the map accompanying this report, but the line of its western boundary is very uncertain.

The principal exposures of the Galena in the county are on Bear and Deer creeks, and at Spring Valley on the Middle Branch of Root river. At the latter place quarries are worked to a greater or less extent by Mr. Willard Allen, Thomas Thayer, Emylas Parsons, and Nelson Smith. These openings are on the south side of the valley and are all in about the same kind of stone. Some of them furnish, as yet, only rough large pieces, water worn and rusty, dislodged from their original places. The rock has undergone long weathering and erosion at Spring Valley, and is disintegrated and changed to a considerable depth. Along the road near the public school, a small cut in the shattered crumbling layers has exposed a great number of detached casts of a brachiopod resembling that of *Atrypa reticularis*. These were regarded with great curiosity by many as "little turtles" petrified. At J. Shumaker's quarry, one mile east of the village, about eight feet of the bedding are exposed. The layers here are of a finer and more uniform texture, and are associated with shale. When cut for building they are much whiter than the stone obtained at Mr. Allen's at Spring Valley. In considerable quantities of Galena are obtained at Spring Valley. No systematic exploration, however, has been undertaken, the pieces found being at or near the surface. It has been found at a number of other points in the county, sometimes well within the Trenton area.

N. W. ¼ sec. 16, Jordan. In ascending the south bluff of Lost creek, large loose pieces of Galena limestone are seen in the road, but the Trenton is in outcrop at the creek. Similar pieces appear

on sec. 31, Jordan. These are on the most eastern limits of the Galena area, and belong to the lowest layers of the formation.

There is a weathered exposure of the Galena on land owned by Mr. —— Harris, northwest quarter section 26, Sumner. This outcrop fairly presents the typical lithological features that characterize the formation. By the Galena characters are meant a yellowish, or buff, limestone, vesicular, crystalline, in heavy layers, even on weathered bluffs, having usually a very rough exterior, in consequence of atmospheric destruction of the looser portions. When these looser portions are removed, the surface of the rock presents a pitted aspect, being covered with thimble holes, and depressions of all shapes, with angular knobs and excrescences separating them, the whole overgrown with lichens. The exposure here shows perpendicularly about twelve feet, in layers from one to four feet thick, piled up on either side of the road in detached mounds, like bridge abutments, from which the roadway has been removed. The "lead fossil," *Receptaculites*, appears in these layers.

At the crossing of the South Branch of Root River, northeast quarter section 21, Bloomfield, there is no cut in the rock visible. The river is but about twenty feet below the level of the country, which is in a broad, shallow valley; but in the road are a few pieces of Galena, showing fossils and lithology like the rock at Spring Valley, though the layers must be near the top of that formation. The country here, and toward the southwest, is a broad level prairie, gently rising toward the west.

Northwest quarter section 26, Bloomfield. The south bank of the river, near the west side of the section, has a rock bluff exposed about twenty feet above the river. This is massive, or in heavy layers, and is doubtfully assigned to the Galena, as it has some of the features of the Niagara. It is firm, but porous; of a buff color and a coarse magnesian grain, with superficial cavities, due to the weathering out of fossils. It is on the land of Mrs. Annie Postle. The crossing of the survey of the Winona, Green Bay and Grenelle railroad is at the head of the bluff. A similarly doubtful exposure, slightly quarried, is owned by Dora Wright, near the center of section 14, Bloomfield, by the roadside. Wm. B. McVee has has also taken out the same stone near his barn, northwest quarter section 14, and used it in his barn foundation. It here holds considerable calcite.

At Etna Mr. S. S. Belding has a quarry in the Galena. This is a soft, porous stone, in heavy beds, which once held fossils, but which have been lost by absorption, leaving the rock porous, and

finely vesicular, Mr. Belding states that this limestone has a hydraulic quality, but as near as can be ascertained it makes simply a quick-lime, which endures well under repeated wetting. An old foundation at De For's Mill was laid with it nineteen years ago, and stands firm yet, though submerged by every freshet. It has not yet been subjected to the test of setting *under water*, which is the essential property of water lime. The rock here seen amounts to eighteen or twenty feet. Other quarries, similar to Mr. Belding's, are owned by O. M. Postle, northwest quarter section 36, Bloomfield, by Geo. Hoy and Mr. De For, northeast quarter section 25, and by H. T. Odell, southeast quarter section 36.

At De For's Mill, N. E. ¼ sec. 25, Bloomfield, the rock exposed is fine and even-grained, belonging probably to the lower portion of the Galena. It embraces one thin layer of a shaly limestone which has turned white. It makes a good quick lime. It is in heavy beds of about eighteen inches, and holds a coarse coralline form seen also at the quarry of Mrs. Postle, already mentioned. Below these heavy layers is a bed of shale which was exposed in the digging of the mill-race, having a thickness of five and a half feet. Below that thickness the shale becomes arenaceous, and in the weather crumbles to pieces. Among the crumbled fragments are indistinct remains of the buckler of a small trilobite.

At Foreston, one mile south of the state line, the Galena appears in the lower river bluffs, and is in very rough and heavy beds. It presents numberless cavities of all shapes, as large as a thimble, and larger, and often iron-stained. It here has a noticeable dip to the south. While it is fossiliferous it is so coarsely and so completely crystalline that the fossils are either entirely absorbed or remain as indistinct impressions or imperfect casts. It contains white calcite in some large masses. The river itself at Foreston is probably on the Trenton, the water-power there improved being due to a change from the firm Galena layers to a softer shale, indicating the upper portion of the Trenton. On the state line, due north from Foreston, a limestone appears in the road, of a coarsely crystalline grain, with calcite and cavities, entirely like the Galena. It is observable in a number of the hill tops, and extends half a mile at least, north of the state line. At a point about a mile north of the state line, north from Foreston, and a fourth of a mile east (N. E. ¼ sec. 35, York) the upper Trenton appears on the N. E. side of a ravine, while the Galena appears on the S. W. side, the road running between the two. The rock has a perceptible dip toward the south. The Galena occupies the high river-bluffs from that point nearly to

Granger, on the north side of the river, when it passes to the south and the Trenton takes its place, both having a dip toward the south. At a point two miles west of Granger the Galena is 15 or 20 feet thick in the top of the river bluffs, the Trenton underlying. These thick beds give a squareness and prominence to the tops of the bluffs, presenting a perpendicular rock-wall toward the river. Large masses of this rock fall from the bluffs and weather into the usual rough forms. Though this exposure embraces rock that is a little softer than the Galena at Foreston, yet in color, crystallization and all general characters it is the same.

The Maquoketa Shales.

This is the name given to the *Cincinnati Group* of shales and limestones, as they appear in Iowa, by Dr. C. M. White, of the Iowa survey of 1870. Without questioning the correctness of his conclusion that where these shales appear in Iowa they embrace a distinct portion, only, of that series known as the Cincinnati Group, his designation is provisionally adopted in our nomenclature. While it is certain that this formation enters the State from Iowa, being seen two miles south of the state line, at Lime Springs, it is still true, that not a single observation has yet been made on it within the limits of the State of Minnesota. Being made up of soft materials its outcrops are to be sought in the low levels, along the bottoms of ravines. As its area in Fillmore county is covered by the northern drift, it will probably be a long time before any well authenticated localities of its existence are known.

The Niagara Limestone.

This formation has been identified in Fillmore county, at but one point. It is much more enduring than the shales underlying it, but it enters on a drift-covered area, with small valleys of drainage only, some distance south of the state line. The nearest important point of its known outcrop is at Lime Springs, in Iowa. It differs from the Galena limestone in being much lighter colored, especially when broken or powdered. It is strongly crystalline, and often porous, but it is also, in some parts, a very firm and enduring limestone. It also has a very different and much more abundant fossil fauna. It is separated from the Maquoketa shales, at Lime Springs, by a limestone breccia of about 18 inches. Its color, in its heavier and close-textured portions, is somewhat grayish, or leaden, and it

is interbedded with hard shale, which turns nearly white on exposure. This shale, in broken pieces, makes up the larger part of the breccia mentioned, and falls down the bluff in that condition, where it is lost in the weather, the framework of the cement only remaining, making a curious, open network or mesh, the partitions and threads enclosing angular apartments. The great bed of shale, which causes the water power here, may have a thickness of 75 or 80 feet exposed, at the quarry of Mr. John Smith, though near the mill it is reduced to ten or fifteen feet. Throughout the most of that interval, a heavy debris covers it from sight, the overlying Niagara only being visible along the top of the bluff. The Niagara has a dip of five or six degrees to the southwest, and passes below the lower Devonian (*Corniferous?*) which is exposed and quarried at Lime Springs station, about a mile further south. The thickness of the Niagara included in that interval may be 100 or 150 feet. This underlying bed of shale gives rise to springs of limy water that enter the river along the bluff, and gave origin to the name of the village.

In the southeast quarter section 33, York, about forty rods north of the state line, is a very small exposure of the Niagara, in the bottom of a ravine, with the Devonian in the enclosing hillsides. A slight opening has been made in these beds, which are very porous and light colored, and about three inches in thickness. Although no fossils were found here to identify the formation, the presence of a very different rock, well known as the Devonian, in the hills and ridges surrounding it, as well as the strong resemblance it bears to the Niagara at Lime Springs, will allow of its being regarded only as the Niagara limestone.

The Devonian Limestones.

In the report for 1874 the Devonian limestones were described as occurring at Le Roy, in Mower county. It was then supposed that those limestones extended but a short distance east of Le Roy. They have been found during the past summer to extend considerably further east, and to embrace an area in Fillmore county fully ten miles wide on the southern border. Along the western boundary of Fillmore county the width of this Devonian belt is not certainly known, but it has about the same width as on the southern Hence the eastern boundary line of the Devonian in Mower county should run from about section 13, Bennington, northwestwardly to about section 7, in Pleasant Valley. The Silurian area, as laid off

on the map of that county, should probably embrace the Niagara, the Maquoketa and the Galena, overlain, in the northeast, (Racine) by the Cretaceous.

The Lower Devonian limestones are very different from the Upper, at least lithologically. Dr. White has classed them all as Hamilton. But there seems to be some reason for separating them into at least two parts, the upper portion, which contains more shale, being the probable equivalent of the Hamilton, and the lower, which greatly resembles the Lower Corniferous, of the Ohio Geological Reports. The distinctively Onondaga features of the Ohio Corniferous are the only ones seen in Fillmore county. The color of this limestone is like that of the Galena, but its even and non-vesicular texture is enough to distinguish it from that at a glance. The bedding is also less thick, being, when in exposure, usually less than eight inches, though when quarried it is in heavy beds. It is a yellowish, magnesian limestone, sometimes with a finely siliceous composition, and is suitable for most purposes in common masonry. It is tolerably free from calcite lumps, but has some chert nodules. It has a few fossil brachiopods, as *Atrypa*, and an incrusting bryozoon like *Fenestella*.

At Lime Springs station is a quarry in the Lower Devonian, exposing about ten feet. At Hopkins' quarry, situated two miles west and a little south of Lime Springs, about twelve feet, in heavy layers, can be seen, without fossils, but holding some flint. Dip southeast. At Chester similar beds are exposed, near the mill, three-quarters of a mile south of the state line. It is here in heavy beds, of a soft, uniform, granular texture and yellowish color, useful for a cut stone.

This rock is probably that which is said to appear in the river banks, section 34, Beaver, on Jerry Kingsley's land.

Southeast quarter section 20, Beaver. This rock is again seen here, exposed along the banks of Slough Creek; owner's name unknown. It here shows a brachiopod resembling *Orthis*, and a radiating *Fenestella*. It is in the midst of an uninhabited prairie, and only weathered pieces can be found.

Southeast quarter section 18, Beaver. About ten years ago a cellar, dug for a farmer's residence, furnished stone of the same kind in sufficient quantity to construct his house, now owned by Mr. James Smith. Similar rock again appears in the road, northwest quarter section 20, Beaver, but is somewhat more vesicular.

Widow Scarrie has a small quarry in a yellowish, fine-grained rock, almost non-fossiliferous, and probably of the Lower Devo-

nian, on the southeast quarter section 28, Bloomfield. Outwardly this much resembles the Cretaceous sandstone, as exposed at Austin, in Mower county, but it has a doubtful brachiopod that appears like *Atrypa*. Its weathered color, its homogeneity and fineness of grain, its irregularly rounded cavities, containing loose, ochreous dirt, combine to make it Cretaceous. It is with some doubt classed as Lower Devonian.

This limestone is found in loose pieces, and often in surface exposures, on the tops of knolls, near the state line, sections 33 and 34, York, the porous, white Niagara appearing in the ravines.

The Cretaceous.

No attempt is made to map out the Cretaceous area in Fillmore county, inasmuch as it is all embraced in the drift-covered portion, and but one or two localities of its existence are known. It probably extends no further east, however, at any point, than the east side of the first tier of towns along the western border of the county. Its area is most reliably indicated by the surface features, in the absence of actual outcrops. Guided by this only it is supposed to occupy the flat and prairie portion of Sumner Township, stretching southward through Spring Valley and Bloomfield and covering the most of Beaver, and perhaps portions of York. Judging from the prevalence of Cretaceous features in the drift-clay exposed in the railroad cut at Lime Springs, it has played an important part in originating the materials of the heavy drift covering that spreads over not only the western portion of Fillmore county, but all the counties of the state further west.

The lower portion of the Cretaceous, which is that represented in Minnesota, consists of sandstones and lignitiferous clays or shales—the sandstones lying at the base of the formation and being the same that Dr. White has denominated in Iowa the "Nishnabotany Sandstone." Above this sandstone, which is often white and incoherent, with a thickness of about one hundred feet, so far as observed, is a clayey member of the Cretaceous which has been identified by Mr. F. B. Meek as the Fort Benton Group, of Messrs. Meek and Hayden. This is well exposed in the region of the Upper Minnesota Valley, and contains some impure lignite, and is found in small pieces disseminated with its fossils, through the drift-clay cut at Lime Springs, a couple of miles south of Fillmore county, in Iowa. The Niobrara, or chalky member of the Cretaceous, may also exist in the extreme western portion of the state.

So far as Fillmore county is concerned the presence of the Cretaceous is known more by certain indirect or secondary evidences, than by the actual discovery of its beds *in situ*. In the extreme northeastern corner of Mower county it was struck by a farmer in digging a well. It there has the form of the fine-grained sandstone seen at Austin. The surface features that prevail at that point pass into the northwestern corner of Fillmore county, and cover the most of Sumner Township. Southward, at Spring Valley, a similar stone appears in the north side of the creek where it has been opened for building purposes by Messrs. James Wilder and Henry Thayer. It is here a fine-grained, argillaceous sandstone that cracks and crumbles on freezing It has been given up as worthless for a building material. Near the same place, on David Higby's farm, S. W. ¼ sec. 32, is a very fine and tough clay, of a generally bluish color, almost entirely free from grit, which is spread out over a wide area lying but few feet below the surface. The overlying soil, which is annually plowed, is a black loam, (rather clayey) varying below to a yellow, clayey loam. This clay was discovered several years ago, but nothing has been done that will demonstrate or indicate its real orgin, though it is evidently not a part of the drift. It has the appearance of being suitable for pottery or for brick, but would require some sand. A soapy, variegated clay also occurs at J. W. Smith's brick yard, two miles northwest of Spring Valley, though a drift clay, with some gravel, is used in the manufacture of brick. A similar clay is met in abundance at Spring Valley village, but it is mingled with limestone fragments and drift materials.

Besides these clayey deposits, which are believed to have resulted from the degradation, or more or less perfect preservation, of the lower Cretaceous clays, there are a number of white sand deposits in the same portion of the county, which probably are referable to the incoherent layers of the Nishnabotany sandstone. One of these occurs north of Mr. J. W. Smith's brick yard, on section 17, Spring Valley. Another is situated on C. C. Temple's land, southeast quarter of section eight, Bloomfield, where it is 20 feet thick at least, having been tested to that depth, the bottom never having been reached. It here occurs in an open prairie country, and is known to spread out over many acres, lying but two or three feet below the surface. It lies on the Galena, of course unconformably. It is not a purely white sand, like the St. Peter, but yellowish white. It is sometimes very fine, but varies to coarse. Another deposit of this sand is on Mr. Andrew McNee's land, northwest quarter section 22, Bloomfield, and still another on J. M. Rexford's, northeast quar-

ter section 36, where it has been opened, as at the other points named, and used for mortar. These are situated in an undulating tract, with some shrubs and trees. These sand beds are not regarded as belonging to the Cretaceous rock *in situ*, but as being copious local products, under drift agencies, of the Cretaceous. Sometimes they embrace lumps of clay, of a greenish color, like the Fort Benton, and sometimes they show oblique stratification. They are entirely uncemented, so as to be shoveled directly into the wagon. Another singular deposit, in the same manner referable to the immediate presence of the Cretaceous, occurs on the southwest quarter section 15, Bloomfield, land of Peter Peterson. Here a series of knolls, which embrace, indeed, that in which is Mr. Andrew McNee's white sand pit, and are covered with aspen and hazel brush, are found, many of them, to be composed of a beautiful, coarse gravel, the greater part being white, often limpid, quartz, the size of the pebbles varying from that of a pea to that of a hazelnut. On these knolls are a few northern drift boulders, and no doubt the gravel was also placed in the position it now occupies by the drift forces. This gravel, so remarkably homogeneous, like the white sand deposits mentioned, can only be referred to the immediate proximity of the lower Cretaceous. It could not have been far transported without being mixed with other rock material. It distinctly points to the existence of a coarse gravel or conglomerate in the lower Cretaceous, which has not yet been discovered. It indi cates also the littoral nature of the Cretaceous beds from which it was derived.

There is still another indirect evidence of the existence of the Cretaceous in the western portion of Fillmore county. There are heavy deposits of limonite iron ore, bearing some unascertained relation to the Cretaceous, or to the drift found in the southwestern part of the county. In the Second Annual Report of the Survey mention was made of the occurrence at a number of places in the Minnesota Valley, and in that of the Blue Earth, of a coating of iron ore on the Lower Silurian rocks, where they are unconformably overlain by the Cretaceous. Dr. Shunard says of this: (*Owen's Geological Survey of Wisconsin, Iowa and Minnesota, page* 487.) "The nodules of iron ore have mostly a concentric structure, and appear to be of good quality. The superficial indications render it probable that this bed of iron ore may be both extensive and easily accessible." In Fillmore county a discovery was made by Mr. C. C. Temple, in digging a well near his sand pit, already described, and referred to the Cretaceous as its probable source, which throws

some light on the manner of occurrence of the limonite referred to. He testifies that *this bed of iron ore is at least thirty-six feet in thickness.* In his well, which is six feet circular at the top, he dug down about eighteen feet, when he reached rock, fragments thrown out revealing the Galena limestone. He describes the rock as occupying but about one-half of the diameter of the shaft he was digging, which afforded great quantities of soft limonite, or ochre. He drilled into the iron ore a depth of thirty-six feet. A number of wells in the vicinity of Etna, a few miles further southeast, also struck a similar iron ore. On section 36, Bloomfield, a great many loose pieces of porous limonite are found in the fields, having been plowed up in the soil. The county surveyor, Mr. J. Gregor, also found it impossible to lay out the quarter sections of that section in the usual manner, by the use of the magnetic needle, though the original United States surveyors record no unusual disturbance of the magnetic needle. Limonite iron ore is regarded usually as non-magnetic. In large quantities, near the surface, it seems to influence the magnetic currents. What relation this ore bears to the Cretaceous is not known, except that it has been found to overlie the Silurian rocks, or to cover their surfaces with a scale where the Cretaceous overlies them unconformably. Further and more minute observations in other places may reveal its real source and its value. The reader is referred to the Second Annual Report for an account of the *Cretaceous over the Lower Silurian* at Mankato, in the Valley of the Minnesota.

The Drift.

The drift presents some interesting features in Fillmore county The western limit of that well-known tract denominated *The Driftless Area*, by Prof. J. D. Whitney, crosses this county. This boundary is not well-defined. There is a very conspicuous absence of the bluish clay, and the northern boulders that distinguish the true northern drift sheet of counties further west and north, throughout the eastern two-thirds of the county; the boundary line running approximately, from the southeast corner of Bristol township to the northeast corner of Jordan. West of that line, which is modified, in its course, by valleys and uplands, is a belt of five or six miles in width, which is characterized by an overlapping of the loess loam on the thinning out edge of the drift sheet. This belt is characterized further by peculiar local modifications of the materials of the drift, due to the underlying rock, as mentioned under

the head of *Cretaceous*. West of this belt the true drift becomes prevalent, consisting of clay, with many boulders.

That tract which is regarded as driftless,* is, so far as Fillmore county is concerned, not without some evidences of having been subjected, at some time, to a force similar to that which is supposed to have deposited the great drift-sheet of the northwest. There are isolated patches of gravel, with small stones, sometimes cemented into a crag, which have been noted in Fillmore county, scattered sparingly over the eastern part of the county, as the following field minutes will show:

Drift pebbles are in the street, north of the schoolhouse, southwest quarter section 22, Amherst.

Drift occurs in the form of gravel and boulders, some of them a foot in diameter, southwest quarter section 4, Fountain, on the east bank of Sugar Creek, in the road; seen in going east from the quarry of Enoch Winslow. At Fountain village there is said to be no drift between the loess loam and the rock.

A little drift may be seen at the Tunnel mills, section 34, Sumner.

There is a little fine drift visible along the road, southeast quarter section 25, Sumner.

At Chatfield there is some gravelly drift, with small boulders, visible in the street, near the millrace.

Drift, with pebbles and stones, appears about a mile south of Clear Grit, on the Shakopee terrace along the highway.

Also on the road to Carimona, near Preston.

About midway between Preston and Carimona, a wash by the roadside revealed—

Loam	8 feet.
Gravelly, red loam	3 feet.

With no distinct separation, a few small boulders lying in the water course below.

At Carimona a thin layer of drift is usually found under the loam.

The same is true at Forestville.

At Spring Valley the drift is so prevalent that the surface of the country is smooth, and has a lighter colored soil, with much more clay. There are but few stones or gravelly patches. The loess loam is hardly noticeable. One large boulder lies at the street corner, half a mile south of the corporate limits.

Between Baldwin's mill, section 21, Forestville, and the state line, due south, the country is one of drift prairie, nearly the whole distance, with stones and boulders, some of the latter pretty large.

At Ætna, section 36, Bloomfield, among a variety of stones pertaining to the drift, may be seen an occasional one that is *glaciated*.

*J. D. Whitney, Geology of Wisconsin, Vol. 1, pages 114–139.

At Lime Springs and Foreston, a few miles south of the state line, on the Upper Iowa river, the drift is abundant.

At Granger there is a light drift, and also where the road turns north to Preston, northeast quarter section 36, Bristol; but it becomes lighter still or entirely invisible, in traveling to Preston. In its place a heavy, rich loam, rather clayey, covers the country, and smooths it off almost as effectually as if drift-covered. A well, being dug about five miles south of Preston, on the high Trenton area, passes through this loam eighteen feet before striking the rock.

The drift is very thin at Lenora, if not entirely wanting.

About four miles southeast of Preston a large green, dioritic boulder may be seen lying in the loess loam, in the road, and a red quartzose pebble. The pebbles that appear in gullies by the roadside, in the loam area, are generally of chert, from the rock of the locality. It cannot be ascertained whether this dioritic boulder lies on other drift deposits, but it is surrounded laterally only by the loam.

At Elliota is a thin drift, in the form of pebbles, the largest being three or four inches in diameter. Thence northeastward to Newburg nothing but the yellow loam is observable. Between Newburg and Riceford, situated on the western edge of Houston county, no northern drift is visible; but at Riceford, which lies in a deep and narrow gorge, a few drift pebbles occur in the street.

About the center of sec. 29, Holt, is a deposit of drift gravel. It may be seen in descending the hill northward, just before the road forks to Whalen and Lanesboro. It is considerably cemented by lime, forming a crag, large lumps of which, some 18 or 20 inches thick, have been used for embankment on the lower side of the road. In some parts it is quite fine, and useful for mortar, for which it has been hauled away. It is at least ten feet thick.

There are boulders in the valley of Duxbury creek, sec. 28, Preston.

Sec. 19, Pilot Mound. In the road going to the river from the south, are a lot of boulders and other drift. The same can be seen on the north side, going up from the ford. The deposit seems to be five or six feet thick, gradually mingling with, and finally becoming replaced by the loess loam.

Drift gravel and stones are seen along the road in going down the hill to Isinours, from Preston.

Drift pebbles and clay occur at the crossing of Watson's creek, on the direct road between Fountain and Preston, and on the terrace of the Shakopee limestone, a quarter of a mile south of the creek.

Boulders are seen at Spring Valley, and on Mr. Kleckler's farm, two and a half miles east of Spring Valley.

An occasional boulder is seen in the river valley at Geiner's Mill, sec. 31, Jordan, but the most of the surface covering on the rock, in the high prairie region, seems to be of loess loam.

East of Highland P. O., in Holt township, sec. 36, is a conspicuous deposit of drift, exposed in the road, in the form of a stony gravel. It lies on the brow of the Shakopee terrace.

It is noticeable that in nearly every instance where drift pebbles

occur in the region known as driftless, they lie on or are very near an outcrop of firm rock. They frequent the brows of the terrace formed by the Shakopee limestone. The above named localities are nearly all embraced within the boundaries of the driftless tract, as already defined in Fillmore county. These patches of northern drift present the appearance of greater age than the drift of the western portion of the county, and are believed to belong to a glacial epoch that preceded the epoch that produced the great drift sheet of the northwest. An "interglacial epoch" separated them. It was probably during that interglacial epoch that grew the peat and coniferous vegetation that has been found in considerable abundance embraced within the great drift sheet, (or at least below fifty feet of drift materials) round its outer margin, as mentioned already in a report on Mower county, and as further demonstrated in Fillmore county. It is this older drift that is covered deeply by the loess loam, and *it is within the loam-covered portion of the county that true river terraces, of alluvial composition, are found.* (Compare *Geology of Ohio, Vol. II., Report on Delaware County.*)

Ancient Peat and Vegetation in the Drift Deposits.

Owing to the great geological interest connected with the discovery made last year of a peaty bed within the drift deposits of Mower county, a careful search was made in the survey of Fillmore county for further information concerning its origin and exact relations.* There were found to be quite a number of places in the western portion of the county where farmers, in digging wells, had struck this bed of vegetation. No opportunity has been afforded to make a personal inspection of this bed, and owing to the indefiniteness of the information derivable from the farmers themselves, and its contrariety, it is thought best to give only the statements of Mr. Calvin E. Huntley, of Spring Valley, a professional well-driller. Throughout the whole of the county there is much difficulty in obtaining ready water for farm and domestic use, and a great many wells are drilled deeply into the rock. This is owing to the canoned character of the rock surface, both within the drift area and the loam-covered portion. These canons serve as subterranean drains, though they are generally filled with drift in the western part of the county. Mr. Huntley furnished the following facts

* For further information on the subject of vegetation in the drift deposits of the northwest, the reader is referred to a paper by the writer in the Proceedings of the American Association for the Advancement of Science, 1875, Detroit meeting.

concerning this bed of vegetation. Some of these localities are within the limits of Mower county:

Northwest quarter section 6, Beaver. Land of Andrew Oleson (Early.) It was found here at the depth of thirty feet, situated on a ridge in prairie country. It was two or three feet thick, and had a blue clay both above and below it—then struck a lime rock.

N. E. ¼ sec. 12, Le Roy, Mower county. Land of D. B. Bosworth. This was also on a high ridge, with blue clay above and below it, and lay at the depth of about 25 feet below the surface. It had a depth of seven feet, and contained "decayed stuff, like pressed hay."

N. E. ¼ sec. 1, Le Roy, Mower county. Land of Ole Knutson (Stoley): found at the depth of thirty feet; five feet thick; blue clay above and two feet of black clay below; then lime rock.

Sec 30, Bennington, Mower county, on land of Gents Everson. This is situated on a flat, and was found from 30 to 32 feet below the surface. It was three feet thick, and lay below blue clay. Below it was gravel to the thickness of eight feet, when the well struck lime rock.

S. E. ¼ sec. 9, Bennington, Mower county; land of John Mehan. It here had blue clay both above and below it, and a thickness of two feet. It lay at the depth of twenty feet. The underlying blue clay was gravelly.

It was met in the same town on Robert Cooper's land, at the depth of twenty-five or thirty feet. It was here on a very high ridge. It was in a blue clay, with gravel both above and below. It was here three or four feet thick. This well was abandoned on account of quicksand.

On the slope, northeast from Mr. Cooper's, it was reported to have been met with at the depth of six or seven feet from the surface, on the land of Mr. Bass.

Sec. 2, Sumner. Land of Wm. Bailey: met a deposit which was embraced between layers of what was then supposed to be lime rock. This deposit was two feet thick, and consisted entirely of wood. Rock was struck at the depth of eight feet. This wood was thirty-five feet below the surface. The owner called the rock "grindstone rock." (This was probably the Austin sandstone, of the Cretaceous, and the wood a lignite belonging to same age.)

N. part of sec 28, Spring Valley; land of A. B. Hutchinson. An irony deposit, having an unknown thickness, was struck at the depth of thirty-five feet.

This was also met in the central part of Racine, on the farm of D. Reed, at the depth of twenty-five or twenty-six feet, having a thickness of two or three feet. It came up in chunks which glistened, and looked like iron ore.

Under the head of *Cretaceous* the reader will find further statements concerning this iron ore. Two miles west of Spring Valley, on the land of O. H. Rose, Mr. Leonard made an observation on a deposit of surface crag. This he found abundantly cemented with iron, lying on a sloping surface, covering twenty-five or thirty

square rods, rendering the land unfit for cultivation, in the vicinity of no rock bluff, and on a prairie country. Iron ore was thrown out of a well S. W. ¼ sec. 24, Bloomfield. It was said to have come out in chunks, and to be as heavy as iron. It rises to the surface and a plow cannot be passed through it. This is owned by Geo. H. Smith. Again on H. T. Odell's land, section 36, Bloomfield, it is found in scattered lumps variously mingled with the soil, and with other stone. These surface pieces are impure, and often hold cemented gravel and pebbles. They are also loose and porous, and pass into ocher. Similar pieces occur on section 1, Beaver, land of O. A. Boynton.

Wood was taken from two wells in Jordan township, sections 29 and 30, on land of M. Robbins and Geo. Hare. This is also on a high prairie. In Mr. Hare's well was said to have been a tree.

Wells.

In order to study further the thickness of the drift, and its lateral extent in the county, a great many observations were made on the phenomena of common wells, and the tabulated list herewith appended will give the results of some of those examinations. It has already been said that there are a great many subterranean streams, especially within the area of the Trenton limestone. Some of these streams gush out along the river bluffs, and give rise to copious springs. Wherever there is an open rock structure, which is not imperviously covered by the drift or by the loam, it acts to receive the surface water and to allow its passage along lower levels to the main river valleys. This necessitates the drilling of a great many wells which penetrate in the rock to a depth, sometimes, of two or three hundred feet before reaching water.

Owner's Name and Location.	Drift or Loam, Feet	In the Rock, Ft.	Total, Ft.	Kind of Water	Remarks.
Public Well, Fountain	12	290	302	.....	Water at 130 feet, but lost it by entering a cavity after drilling five or six feet deeper.
W. H. Strong, Carimona	20	43	63	Good.	Drilled.
Poor Farm, section 4, Canton	22	30	52	Good.	In yellow sandrock; last two feet in clay.
Wm. Holton, Carimona	22	38	60	Good.	Drilled.
J. H. Hall, N. E. ¼ section 9, Bloomfield	41½	.....	41½	Good.	Sand and clay.
E. Steffins, Spring Valley	6	80	86	Good.	"On the ridge."
Col. C. G. Edwards, Spring Valley	6	47	53	Good.	"On the ridge."
Calvin E. Huntley, Spring Valley	7	31	38	Good.	Very Hard water.
Peter Swab, section 6, Jordan	8 in.	69	70	Good.	In a "red sandstone."
Wm Twiggs, 1½ miles S. E. of Spring Valley	10	40	50	Good.	Three wells; same depth.
S. S. Belding, Etna	10	22	32	Good.	Hard water.
J M. Rexford, N. E. ¼ section 36, Bloomfield	20	75	95	.....	
James Smith, S. E. ¼ section 18, Beaver	5	50	55	Good.	Water in limerock.
A. C. Seelye, Lenora	20	55	72	Good.	
M. L. Potter, Lenora	90	.....	90	Good.	No rock.
Old town Well, Lenora	About 20	.....	55	.....	"In a large crevice in the rock."
Wm. Barton, 1½ miles N. of Lenora	20	110	130	.....	
James Walsh, section 20, Amherst	13	67	80	.....	Sandrock and limestone; water in limestone.
Wm. Kimber, S. W. ¼ section 29, Amherst	34	82	116	.....	
S. S. Stark, N. W. ¼ section 2, Amherst	28	100	128	.....	Gets dry in summer.
Henry Rose, N. E. ¼ section 3, Amherst	25	117	142	.....	Gets dry in summer.
Public Well, Highland P. O	.....	.....	65	.....	
Andrew Vogt, S. W. ¼ section 20, Amherst	7	85	92	No water.	Well incomplete.
Mrs. Simmons, section 35, Spring Valley	8	35	43	Good.	Last three feet in bluish-green shale.
Public well, Spring Valley	12	2	14	Good.	
A. N. Hart, Spring Valley	14	6	20	.....	Last foot in bluish limestone; Some "oily blue clay."
S. W. Knight, section 11, Fillmore	15	95	110	Tolerably good.	
S Hoff, Fillmore	18	8	26	Good.	Eight feet in St. Peter sandstone.
D. S. Hoff, Fillmore	18	.....	18	Good.	Sand and gravel.
John Kleckler. S. E ¼ section 26, Spring Valley	4	27	31	Good.	Twenty-seven feet in Trenton limestone.
F. Greaves, Chatfield	10	40	50	Good.	Forty feet in blue limestone.
Th. Simpson, Chatfield*	9	31	40	Good.	Thirty-one feet in blue limestone.
W. H. Dunham, Chatfield township	10	50	60	Good.	Ten feet yellow clay and stone.
Elisha Leonard, section 14, Sumner	17	.....	17	Good.	Six feet of water.
J. B. Silbert, 2 miles E. of Spring Valley	19	.....	19	Good.	Two layers of gravel.
C. B Brocksom, 2½ miles E. of Spring Valley	16	33	49	Good.	Nine feet in drift; seven feet in loose rock.
F. Lageirg, 3 miles E. of Spring Valley	About 20	32	52	Good.	
J. H. Hall, 2 miles S. of Spring Valley	27	14½	41½	Good.	Clay, quicksand and bluish stone.
O. H. Rose, 2½ miles W. of Spring Valley	20	29	49	Good.	"Found a vein of Venetian Red 10 feet from the surface."
O. H. Rose, 2 miles W. of Spring Valley	8	48	56	Good.	Soil, gravel and clay.

* There are but few wells in Chatfield, because of the necessity of drilling from twenty to a hundred and fifty feet in the limestone.

The price charged by Mr. Huntley, of Spring Valley, for drilling wells, is one dollar per foot the first fifty feet, with twenty-five cents per foot added every ten feet thereafter. Messrs. Sands & Tousley, Amherst, receive fifty cents per foot before striking the rock, one dollar and twenty-five cents per foot for the first twenty feet in the rock, and add twenty-five cents per foot every ten feet.

The Loess Loam.

The greater portion of the county is covered with this loam. It contains no gravel or boulders, or with very rare exceptions, but consists almost entirely of fine siliceous material which becomes in some places quite clayey, making a very slippery mud when wet. This in outward appearance is of a light, yellow or rusty color, and differs in that respect from the loam seen on the drift-covered portion of the county, which is frequently black, or brown, varying to an ash color when mingled with a considerable per cent. of clay from the drift, and also contains gravel. The loess-loam is very homogeneous over wide tracts, while that in the drift area is subject to local and sunden variations. The loess-loam is indistinctly stratified, especially in the valleys, but the usual appearance is that of non-stratification. This stratified arrangement is rendered the less evident from the great similarity of the materials from the top to the bottom. It does not consist, apparently, in any change from coarse to fine in the sedimentation, but in a *lamination* of the homogeneous clayey, loam, and is easily obliterated by exposure, or by trickling water. This condition was noted particularly at Preston, and indicates that it was deposited in still, or gently moving, water. Where this loam lies over the old northern drift, it pass through a gravelly stage, the materials of the loam mingling with the coarser portions of the drift, and becoming finally replaced by the drift. The drift patches covered by this loam, pertaining to the eastern and central portions of the county, and believed to belong to an earlier drift epoch, are, so far as seen, made up of gravel and sand, with small stones. *No drift clay*, like that which covers the western part of the county, has been seen overlain by the loess-loam, except that which pertains to the general drift sheet of the northwest, and which occupies a narrow belt of 5 or 6 miles wide, where the loam overlaps the later drift. It would be reasonable, however, to expect that some such clay would be found. The pebbles that are thus mixed with the lower portion of the loam are smooth and waterworn, not covered with a coating of decayed

material of the same nature as the pebbles themselves, as they would be expected to be if the loam were derived from the decay, *in situ*, of the materials of the drift. The thickness of the loess-loam sometimes reaches twenty feet in the open upland, and, under favorable circumstances, where it might have accumulated laterally, as well as perpendicularly, it is much more. It is tickest in the eastern part of the county.

Alluvial Terraces.

At Preston, besides the flood plain, the river has a high terrace-plain. The Stanwix House stands on it. It consists of loam undistinguishable from the loess-loam that covers that portion of the county. The same may be seen at Lanesboro, and at Whalen, but it is not conspicuous. At Rushford fragmentary remains of this high terrace are seen in the valleys of the tributary streams. Along the main valley they are not well preserved. There are two terrace levels, besides the flood-plain. The highest terrace plain is from 70 to 80 feet above the second, and about 130 feet above the river. The lower terrace, on which Rushford stands, is about 40 feet above the river, and is probably never reached by the river in even the highest water. Within this lower terrace-plain, which spreads out laterlly and forms the most of the alluvial land between the rock-bluffs, is the river channel, and a still lower flood-plain about 20 feet above the river at low stage. A similar high terrace is seen along the Mississippi river at Winona, in Winona county, rising about 95 feet above the river, while the flat on which the city of Winona stands is about 25 feet above the river at the boat landing, in low stage of water. At Rushford and Winona the high terrace consists of a material different from the loam that overspreads the country, being made up of stratified sand. This terraced condition of the valleys of Root river, and of the Mississippi, is confined, so far as observed, to the loam-covered area, which nearly coincides with the "driftless area," as defined and described by Prof. Whitney.

Material Resources—Fuel.

In addition to the products of the soil which will always be her chief source of material wealth, Fillmore county cannot expect any important mineral discoveries to augment her material prosperity. She has a good supply of forest for purposes of common

fuel, and will not suffer from the absence of coal, as some of the counties further west have suffered. She will have to depend on her native forest trees, or on those that are being propagated successfully, for the most of her home fuel supply. There is as marked an absence of peat in this county as there is in Mower, but a single locality being noted. That occurs on S. E. ¼ sec. 26, Spring Valley, land of John Kleckler and David Broxlem, and is said to be about four feet thick, covering four or five acres. There is no doubt but other, isolated, small areas, of a turf-peat, also exist in the county, but the circumstances which promoted the production of so large a surface of peat in Freeborn county, are certainly wanting in Fillmore county. The frequency of lakes and swamps, and abundance of peat, coinciding as they do in Freeborn county, taken with the absence of both in Mower and Fillmore, point to the existence of a common cause for these surface features.

Iron.

Throughout the western portion of the county there is a great deal of surface iron, manifesting itself generally in the form of a cement in gravel, forming a dark-colored *crag*. There is also much evidence of the existence of a heavy continuous layer or deposit of limonite iron ore a few feet below the surface, in Bloomfield and Beaver townships. The details of these localities, and of the evidence of iron, so far as ascertainable, have been given under the heads of *Cretaceous* and *Drift*. Should this bed prove to be extensive, its actual value for commercial purposes may vary greatly from its intrinsic value. It consists of a loose-textured hydrated peroxyd, with ochery impurities, and bears a close resemblance to some bog-ore deposits; but its occurrence on high land, instead of in swamps, necessitates some other explanation for its existence than that ascribed to the occurrence of most bog-ore deposits. It may have originated during that swampy condition of Southern Minnesota when the peat grew that is embraced in the drift deposits, as already detailed. It is not probable that it will ever be found valuable for the manufacture of iron. Before the opening up of the vast, and richer, iron ore beds of Michigan and Missouri, the bog-ores were considerably used in the production of iron, on a small scale, in several of the western States, but the small furnaces that smelted them have all ceased operations many years ago. Another obstacle to the utilization of this deposit in Fillmore county, will be the lack of fuel in convenient and sufficient quantities.

Lead.

While the Galena limestone, which is eminently lead-bearing at Dubuque and Galena, passes, in its northwestern trend, across the southwestern portion of Fillmore county, it has not been discovered to afford the same amount of lead as in Iowa and Illinois. Indeed, at points more remote from the Mississippi river, in Iowa, no remarkable deposits of lead have been obtained from it. There is not a total absence of lead from its layers, since a few localities are known to have afforded it in limited quantities. The same is true of the lower Trenton; which seems to indicate that the presence of lead in the limestones of this region does not depend on the kind or age of the formation, but rather on some later, superimposed conditions that prevailed over the region, subjecting various formations to the same influences.

Quicklime.

All the limestones of the county are suitable for quicklime, but by far the greater quantity is made from the upper Trenton. In the townships of Sumner and Spring Valley, all the circumstances necessary for the cheap and rapid production of quicklime of the best quality co-exist, viz.: a suitable limestone, abundant exposure, and plenty of fuel. The Trenton there forms some of its characteristic outcrops, constituting the bluffs of the streams continuously for many miles, and rising a hundred or a hundred and fifty feet above the valleys. The kilns are built at the foot of the bluff, and the stone is cheaply obtained, without much cost of transportation. Wood is also abundant at present, much of that portion of the county being covered by a heavy forest growth.

The following list of lime-burners, with their localities and estimated production for the year, will give some idea of the extent of the business now carried on:

Palmer and Miller, Bear Creek, three kilns	2,000 bushels.
N. E. Fetterly, Bear Creek, three kilns	5,000 bushels.
L. G. Odell, Bear Creek, three kilns, (one draw-kiln)	5,000 bushels.
Charles Gorton, Bear Creek, one kiln	1,000 bushels.
Allen Brothers, Bear Creek, one kiln	1,000 bushels.
J. Finley, Bear Creek, one kiln	2,000 bushels.
Isaac Kegley, Bear Creek, one kiln	600 bushels.
Lem. Stout, Bear Creek, one kiln	2,000 bushels.
T. J. Hammer, Bear Creek, one kiln	2,000 bushels.
Elder Cyrus Young, Bear Creek, two kilns	Not in use.

Harvey McQuillan, Bear Creek, two kilns..... Not in use.
Olds and Braley, sec. 9, Spring Valley, one kiln..... 2,000 bushels.
I. N. Cummings, sec. 11, Spring Valley, one kiln.....
J. H. Hall, sec. 12, Spring Valley..... 3,500 bushels.

These all burn the upper Trenton, and there is no noteworthy difference in the quality either of the rock or of the lime produced. According to the testimony of several, however, there are certain layers, near the bottom of the formation, which are not suitable for quicklime. Some layers also are arenaceous, and have to be avoided, but the great mass of the rock is exceedingly well adapted to making quicklime.

The kilns used are, for the most part, of the rudest construction, presenting no improvement over the ancient and well-known "pot-kiln." They have to be emptied and refilled for every burning. Mr. L. G. Odell has the only draw-kiln seen in the county. In this part of the county, mixed wood sells for two dollars or two dollars and fifty cents per cord. The average price of lime is twenty-five cents per bushel, but it fluctuates from twenty to forty. In July, 1875, it was selling for twenty cents; but in September it brought forty cents. The lime itself is generally nearly white after being burnt, but in some places it has an ashen white color, though on slacking it is always white. It slacks with rapidity, evolving considerable heat. It requires from sixty to seventy-two hours to burn a kiln, depending on the size of the kiln, and somewhat on its shape, and consuming about ten cords of dry mixed wood. When freshly and thoroughly burnt, one bushel by measure weighs about 75 pounds, but if not well burnt, it will exceed 80 pounds. "Delivered at Spring Valley, by weight it is sold at the same price as by measure at the kiln." When shipped from Spring Valley it generally goes west, to points along the Southern Minnesota railroad, and is known as *Spring Valley white lime.*

Throughout the county, where the Trenton limestone appears, there are other lime-kilns that supply the local demand. The following were noted:

At Carimona, by William Renslow.
At Forestville, by Frank Turner.
At Chatfield, by Dennis Jacobs.
Sec. 35, Carimona, by Mr. Rollins.
Sec. 25, Canton, by Simon Houck.

The Shakopee is not used for making lime in Fillmore county, though it is extensively burned in the lower Minnesota valley, at

Mankato and at Shakopee, The St. Lawrence limestone is somewhat employed for this purpose, and affords a lime that is nearly white, and is said to weigh 80 pounds per bushel of measure. At Lanesboro this lime sells at $1.25 per barrel, or fifty cents per bushel, wood costing five or six dollars per cord. Mr. Sherman's kiln holds about 300 bushels, and requires 10 to 11 cords of wood for thorough calcination, burning about 48 hours. But little is shipped from here. The lime is about white, and slacks perfectly white. The following list embraces all known kilns that are run from the St. Lawrence:

At Lanesboro, by B. Sherman.
At Lanesboro, by Moses Greer.
At Lanesboro, by Mr. Butler.
At Rushford, by Jos. Otis.
At Rushford, by Wm. Crampton.

Brick.

There is no lack of materials for making common red brick. In some places the surface of the drift clay is used, containing some fine gravel, and at others the loess-loam. Brickmaking machinery was met with in the survey of the county at the following points:

Sec. 20, Spring Valley, J. W. Smith.
Forestville, Michael Shields.
Preston, Franklin Coleman.
Lanesboro, Thomas Dunsmore.
Chatfield, Wm. Stafford.
Lanesboro, W. H. Roberts.
Rushford, Ole Tuff.
Granger, (formerly,) Mr. Ferris.
Peterson, ———.

Gold, Copper.

In small quantities gold has been washed, by rude methods, from the drift at several points in the county. It was found on Luke Hague's land, in gravel, northeast quarter section 26, Spring Valley, and at Yeariton's saw mill, section 31, Jordan. There are accounts also of fragments of native copper having been found in the drift. It is hardly necessary to say that these discoveries do not indicate any valuable deposit of the kind in the rocks of the localities where they may be found. They pertain to the drift, and have

been transported hundreds of miles along with the other foreign substances in which they occur, from the northern part of the State. Such discoveries have sometimes awakened an interest that has culminated in stock companies formed for mining, and in the wasting of thousands of dollars. Similar small quantities of gold can be got by a minute washing of the drift at almost any place where the drift sheet is attenuated, or where the older glacial drift has been denuded, leaving the gold, which is indestructible, either by the lapse of time or by the chemistry of the elements, on the rock surface underlying. Almost every geological report in the country makes mention of them, extending at least through Ohio, Illinois, Indiana, Wisconsin and Iowa.

Building-Stone.

With this necessary article Fillmore county is also well supplied, and it has been put to an extensive use. There are hundreds of openings made to supply a local demand, besides a great many more extensive quarries which are known for a good many miles round. A great deal of stone for building is shipped to counties west, which are drift-covered, and without accessible building stone. Probably three-fourths of the building-stone used in the county is derived from the Trenton, the other fourth being made up of the Galena and the St. Lawrence. The Lower Trenton is most frequently employed. This is largely owing to the prominent manner of its outcrops, as shown under the head of *Drainage* and of *Surface-Features*. The Upper Trenton has been used in the construction of several schoolhouses and private residences. At Spring Valley the Galena is principally used. At Lanesboro, Whalen, Peterson and Rushford, the St. Lawrence. The Shakopee and Jordan are but rarely resorted to.

Probably the best known quarry in the county is that of Mr. Joseph Taylor, near Fountain. It is situated near the railroad, from which a side track allows the loading of cars. It is in the Lower Trenton, and supplies the "blue limestone" that is so largely shipped by the Southern Minnesota Railroad to points on its line in Mower, Freeborn and Faribault counties. The beds are usually less than six inches in thickness, and they are easily broken to any desired size. It is a hard stone, not easily cut, but can be dressed if necessary. It is not injured by disseminated shale, as much of the Lower Trenton is, and hence makes a very durable material. Mr. Taylor delivers it on the cars at $4.50 per cord of 128 feet. At Fountain are several buildings constructed of this stone.

Besides the quarries in the Trenton that have been mentioned in giving the scientific geology of that formation, a number were visited at which no new facts of interest were noted. Such were Ole Oleson's, northeast quarter section 36, Harmony; Wm. Wilbright's and Martin Quinn's, section 15, Forestville: George Drury's, section 3, Bristol; Garrett Mensing's, southwest quarter section 27, Forestville. It would be impossible, and unnecessary, to mention all the places where this limestone has been wrought. In traveling over the county a number of stone houses for residence were seen, belonging to farmers. Such are O. O'Hara's, southwest quarter section 18, Amherst, from the Trenton; Mr. George Park's, section 37, Bloomfield, from the Galena of Mr. S. S. Belding's quarry. The stone mill at Preston is of the Trenton. Of the quarries in the Galena at Spring Valley, those of Mr. Shumaker and of Mr. Allen are the most important. The former furnishes a beautiful fine-grained cut-stone for trimmings, as well as stone for common walls. The latter supplies a darker-colored, and coarser stone, which has been considerably used.

From the St. Lawrence limestone a very fine building stone is obtained. It is a fortunate circumstance that very much of this formation is in regular, and often in heavy layers. These are also not so firm as to resist the usual means for quarrying. When the beds are broken the blocks are found to possess often a finely vesicular texture. Their color is a very light yellow, or buff, resembling that of the well known "Milwaukee brick." The principal buildings at Lanesboro, including the Lanesboro Hotel, the flouring mill of Thompson & Williams, the Presbyterian and Catholic churches, the public schoolhouse, and a number of stores, are of the St. Lawrence, quarried at Lanesboro, and from land owned by the Lanesboro Company. At Whalen are excellent opportunities for obtaining this stone in its best condition. It has been somewhat wrought on Whalen's Bluff. Quarries in the same are owned at Rushford by Wm. Crampton, Jos. Otis and Hiram Walker. Mr. Crampton's quarry furnished the stone put into Boyam's store, and also that of A. K. Hanson's. Mr. E. Larson's was built from Mr. Otis' quarry, and that of Kierland & Son from Mr. Walker's. At Amherst P. O. the Jordan is quarried some for foundations, and the Shakopee at Chatfield.

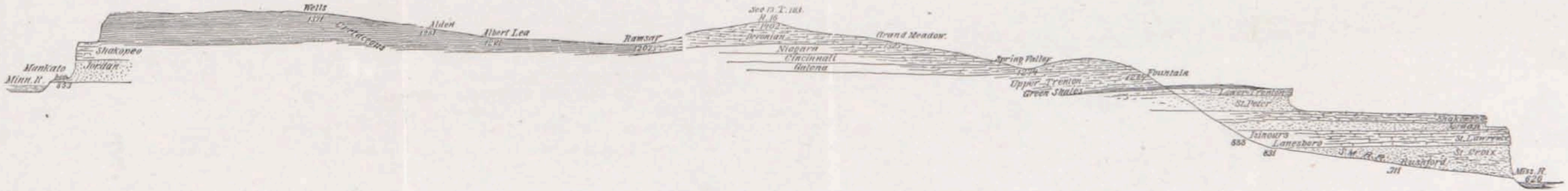
Sand for Mortar and Concrete.

Wherever the St. Peter sandstone is accessible it is employed for making mortar. It is equally good for hard-finish, being, when ta-

ken from some depth, purely white and of very uniform fineness. There are, however, some portions of the county where it is much more difficult to obtain a sand suitable for common mortar. In the western part of the county a white sand, or one nearly white is obtained from deposits referable to the Lower Cretaceous. These have been mentioned under the head of *Cretaceous*. They are found on the land of C. C. Temple, southeast quarter section 8, Bloomfield, on section 17, Spring Valley, on Andrew McNee's land, northwest quarter section 22, Bloomfield, and on J. M. Rexford's, northeast quarter section 36. Mr. Temple deliver's sand at Spring Valley for $1.75 per load, of two tons. One team can haul five such loads per day, but generally hauls but three. From three to five hundred dollars worth are taken from Mr. Temple's sand pit annually. Besides these sources for mortar-sand, the Jordan sandstone, which is often as incoherent as the St. Peter, can be used to advantage, though it is rather more apt to be cemented by iron. There can be no question but the compact and impervious nature of the green shales of the lower Trenton have preserved the incoherency of the St. Peter, by preventing the downward percolation of ferriferous and calcareous waters, which certainly would have left their impurities in the form of cement among its beautiful white grains.

The proximity and cheapness of lime and sand have suggested the building of houses by mixing these substances in the form of a concrete. Several such are found at Fillmore, also in Jordan, and at Rushford; but this method is not general. The material is cast in the form of large brick, having the color of common brown mortar, and these blocks are laid up much like common brick walls. Patent presses are used to make the concrete blocks.

FIG. 10.



SECTION FROM MANKATO TO LA CRESCENT WITH THE STRATA IN THE HORIZON OF THE SOUTHERN MINNESOTA RAILROAD.

GEOLOGICAL MAP OF OLMSTED COUNTY, MINN.

BY M.W. HARRINGTON.
1875

Explanation
Cretaceous
Galena
Trenton
Ut. Peter
Shakopee &c.
Marsh
Timber

GOODHUE CO.
WABASHA CO.
DODGE CO.
MOWER CO.
FILLMORE CO.

NEW HAVEN
ORONOCO
FARMINGTON
KALMAR
CASCADE
HAVER
ELLVIOLA
QUINCY
SALEM
ROCHESTER
MARION
EYOTA
DOVER
ROCK DELL
HIGH FOREST
PLEASANT GROVE
ELMIRA

T108N
T107N
T106N
T105N
T104N

RXVW.
RXIVW.
RXIIIW
RXIIW
RXIW

NEW HAVEN
GENOA
ORONOCO
Potsdam P.O.
BYRON
ROCHESTER
CHESTER
WINONA & ST. PETER R.R.
EYOTA
DOVER CENTER
MARION
Carrollville P.O.
NORTH FORK ROOT RIVER
Rockdell P.O.
PLEASANT GROVE
CUMMINGSVILLE
CHATFIELD
Stewartville P.O.
HIGH FOREST
Six Oaks P.O.
Little Valley P.O.

Geological and Natural History Survey of Minnesota—Fourth Annual Report.

REPORT ON OLMSTED COUNTY.

BY M. W. HARRINGTON.

This large and wealthy county lies in the second tier of counties north of Iowa. It is separated from the Mississippi River by Winona county on the east. Fillmore and Mower counties on the south separate it from Iowa. It is bounded on the west by Dodge county and on the north by Goodhue and Wabasha counties. Olmsted county is nearly a rectangle with five ranges of townships east and west and four ranges north and south. The geometrical figure is rendered irregular by Wabasha county which takes out two townships from the northeast corner. This irregularity is farther increased by an east and west row of twelve townships on the western part of the south side of the county, and extending half a section farther west than the rest of the county. The county contains 18 complete townships of 36 sections each, and twelve sections in addition, making 654 sections or square miles in all.

The following table gives the area in acres of each of the townships of the county. It is from the office of the State Auditor, Hon. O. P. Whitcomb:

Name.	Township N.	Range. W.	Acres and Fractions.
Elmir	105	11	23,008.69
Dover	106	11	23,019.01
Quincy	107	11	23,038.81
Orion	105	12	22,992.53
Eyota	106	12	22,983.90
Viola	107	12	22,977.97
Pleasant Grove	105	13	23,020.18
Marion	106	13	22,963.10
Haverhill	107	13	23,005.91
Farmington	108	13	22,810.11
High Forest	104	14 (6 sections)	26,804.42
	105	14	
Rochester	106	14	22,973.76
Cascade	107	14	22,915.45
Oronoco	108	14	22,968.06
Rock Dell	104	15 (6 sections)	26,809.22
	105	15	
Salem	106	15	23,002.35
Kalmar	107	15	22,990.60
New Haven	108	15	23,057.89
Total acres and fractions			421.341.96

Drainage.—Streams are plentiful and their fall moderate. The water reaches the Mississippi by three paths. The central, northern and western parts of the county are drained by the Zumbro River. This stream runs north into Wabasha county, when it turns east and makes its way to the Mississippi. It comes into Rochester from the southwest, and within the city limits Bear Creek, from the southeast, Silver Creek, from the east, and Cascade Creek, from the west, empty into it. Near the north line of the county it receives quite a stream resulting from the union of the Middle and North forks of the Zumbro. The southern tier of townships are drained by Root River, which, very sinuous, takes a generally east course for the Mississippi. It has in the county no affluents of any size, except at Chatfield, where a stream of small size comes in from the north On the eastern border of the county some branches of the small Whitewater River reach this county.

There are no lakes in the county. There are a few small ponds which in no sense deserve the name of lakes. Streams which sink into the ground and disappear are said to be not rare. The U. S. surveyor's plat of Farmington township lays down one such stream. Another is laid down on other maps in Elmira township; and another in Haverhill and Viola townships. From reports in various parts of the county, it seems they prevail where either the Lower

or Upper (Galena) Magnesian limestone occurs—a state of things to be expected, as will be noted when these formations are discussed.

Living springs of cool, pure water, of the best quality, are not rare. They are by far most common on the south or west sides of bluffs, where the green clay of the lower part of the Trenton Limestone comes to the surface. This clay is impervious to water. The formations dip slightly toward the southwest. The layer of clay forms a nearly level floor of which the southern and western sides are lower than the others. The water will consequently come out on these sides. The springs are frequently of large size. The phenomenon of a row of springs some distance up the sides of a bluff, while the base of the bluff furnishes no springs, is by no means a rare one. Spongy earth is apt to collect about the mouth of the spring. When filled with water, it is soft and very miry. In former times, when the road crossed such spots, bad mudholes were found. They have now been generally tapped and drained, though they are still occasionally met on the less-traveled roads.

Water-powers.—Olmsted county is more than usually favored with good water-powers. This results from the large number of streams, the swiftness of their currents and the favorable nature of the banks and bottom. The information which is given in the following table was derived from Mr. F. T. Olds, of the firm of Olds & Fishback, owners of Rochester City Mills, and from John M. Cole, owner of Zumbro Mills.

Water-Power Mills in Olmsted County.

Name of Mills.	Owner.	Location.	Stream.	Feet of Head.	Run of Stone.	Capacity per day.
Rochester City Mills	Olds & Fishback.	Rochester City	Zumbro	16	4	100 bbls.
Zumbro Mills	Jno. M. Cole	"	Zumbro with Bear Creek	10	4	100 bbls.
Cascade Mills	Lyman Tondro..	"	Cascade Cr...	17	2	50 bbls.
Woolen Mill	Wm. Bartley	"	Bear Creek..	17	.....	50 horse power, only partly improved.
Oronoco Mills	Allis, Gooding & Hibberd	Oronoco Vil..	Zumbro	15	7	150 bbls.
Middleton's Mill.	R. Middleton	Kalmar	"	6½	2	35 bbls.
Saw Mill.	Jas. Button	New Haven...	"	6	.....	
Stewartville	Chas. Stewart...	High Forest..	Root	12	.....	50 bbls.
.....	J. Fugle	Orion	"	8	.....	50 bbls.
Custom Mill	— English	"	"	small.	small.	
Quincy Mills	.....	Quincy	Whitewater.	10	2 or 3	
Saw Mill	— Ambler..	New Haven...	Zumbro	10	.....	

Several unimproved powers are reported. There are some between Rochester and the north boundary of the county, but bad bottom and banks prevent their improvement. There are said to be two good powers between Oronoco Mills and the main stream. An unimproved power is said to be found at Genoa. At High Forest village a water-power was improved years ago, but has been permitted to go to ruin.

The *Surface* is much diversified and the natural scenery very pleasing to the eye. The surface is generally rolling. Along the streams bluffs are found sometimes nearly 200 feet high. These bluffs are usually steep, level-topped, and characteristic of the geological formation which makes them. They are most common in the central and eastern parts of the county. Rochester lies in a valley, with bluffs all around it. It climbs the bluff toward the west. Dover Center, Marion and Chatfield lie in similar valleys. Curious isolated mounds are common, especially along the east side of the Zumbro in the southwest corner of Farmington and the adjacent corners of neighboring townships. They are also common in Elmira. Toward the west the surface is much more level. Much of Rock Dell township is like the prairies just south and west of it. The name of the township is derived from two or three rocky dells in its northern part.

The following notes were taken from the plats of the government survey of the county. These plats were not dated, but according to the State Auditor's records the county was surveyed in 1854 and 1855. They were found in the office of the county register, where access was given to them with the utmost courtesy:

Farmington.—(T. 108 N., 13 W.) This was a prairie township. From an isolated bluff in section 19 extended a stream which sank in about the middle of section 28. The magnetic variation varied from 8° 24′ to 9° 51′. Several marshes of some size were recorded.

Oronoco.—(T. 108 N., 14 W.) No marshes worth noting are shown on this plat. Wood accompanies the streams, varying from one to three miles in extent. The Zumbro on this and other early maps is called the Embarass R. The bluffs along the river are sometimes marked 100 feet. The magnetic variation varied from 8° 24′ to 9° 55′.

New Haven.—(T. 108 N., 15 W.) This township is represented as quite uneven, and bluffs occur along the streams. Woods follow the streams, and two or three aspen thickets are marked. The magnetic variation was 8° 55′ to 9° 54′.

Quincy.—(T. 107 N., 11 W.) This was mostly prairie when sur-

veyed. There was some wood along streams, and a few scattering thickets. A single small marsh was marked. Bluffs accompany the streams. Magnetic variation, 8° 27′ to 9° 51′.

Viola.—(T. 107 N., 12 W.) Several small marshes were marked. A range of prairie extended, east and west, through the middle. Prairie also occupied the northeast corner. Bluffs accompany the streams here also. Magnetic variation, 8° 26′ to 9° 34′.

Haverhill.—(T. 107 N., 13 W.) About half of the town is prairie. Woods extend, as usual, along the streams, which are accompanied by bluffs. Several marshes, none of great size, are platted. Magnetic variation, 8° to 9° 41′.

Cascade.—(T. 107 N., 14 W.) There are no marshes laid down in this township. It is nearly all prairie-land, brush accompanying the streams generally, and a few scattering thickets being marked. The bluffs along the river are sometimes quite elevated for the county. Magnetic variation, 8° 13′ to 9° 33′.

Kalmar.—(T. 107 N., 15 W.) Rather heavy timber occupies the northwestern part. An isolated grove is marked in sections 13 and 14. A single marsh is laid down in sections 11 and 12. The banks of the fork of the Zumbro are bluffy. Magnetic variation 8° 36′ to 9° 35′.

Dover.—(T. 106 N., 11 W.) The township is an essentially prairie one, though many isolated thickets are marked, and there is some wood along a branch of the Whitewater river. The marshes are few and insignificant. The magnetic variation is from 8° 40′ to 9° 50′.

Eyota.—(T. 106 N., 12 W.) A broad belt of timber, about three miles wide, crosses the township diagonally from the northwest corner. The magnetic variation, 9° to 10° 40′.

Marion.—(T. 106 N., 13 W.) Several marshes are given. The land is wooded along the streams, leaving about one-third of the township in prairie. Magnetic variation, 8° 40′ to 10°.

Rochester.—(T. 106 N., 14 W.) The township is mostly brushy, with scattering timber. Bluffs accompany the streams. Several marshes are laid down. Magnetic variation, 8° 15′ to 9° 50′.

Salem.—(T. 106 N., 15 W.) Two marshes of about 120 acres each, and one of about 160 acres are given. About two-thirds are marked as wooded, but the prairie portion comes at the north, where the streams are most abundant. The streams are not marked as bluffy. Magnetic variation, 8° 47′ to 9° 38′.

Elmira.—(T. 105, N. 11 W.) This township was about half-wooded. An independent drainage is marked in sections 8, 9,

16, 17. Bluffy mounds not on streams are marked. Magnetic variation, 8° 45′ to 10° 55′.

Orion (T. 105 N., 12 W.) is somewhat wooded along streams. In sections 10 and 15 a stream is represented as sinking. The banks of Root river are bluffy. A small lake is given in sections 35 and 36. Magnetic variation 9° 20′ to 12° 12′.

Pleasant Grove.—(T. 105 N., 13 W.) A large marsh of about 120 acres is laid down in the southern part of the township. A band of woods about 3 miles wide accompanies the river, the banks of which are bluffy. Magnetic variation 8° 25′ to 10° 57′.

High Forest.—(T. 105 N., 14 W., with a range of sections in T. 104 N., 14 W.) A large marsh—about 320 acres—is laid down in sections 30 and 31. The township is wooded along the streams, but is about half prairie. Magnetic variation 6° 45′ to 9° 55′.

Rock Dell.—(T. 105 N., 15 W., with a range of sections in T. 104 N., 15 W.) A large marsh—320 acres—in the northwestern part. The land along the streams is little wooded. The banks of the streams in the northern part are bluffy; in the southern, not. Magnetic variation 7° 40′ to 9° 18′.

There seems to be no easily recognizable order in the magnetic variation for different parts of the county. The extremes were 6° 45′ and 12° 12′, in High Forest and Orion respectively. Both these towns are on the south side and not far apart.

Some *elevations* have been taken on lines of railroad, built or proposed, through the county. Those of the Winona and St. Peter R. R. I have not been able to see. Mr. W. D. Hurlbut tells me that the survey for this railroad makes Eyota 1,210 feet above the sea, and gives the same height (1,210 feet) to Byron.

The following are elevations on the line of a proposed railroad from Wabasha to Austin, and along the lines of several other proposed roads. Some of them fall in neighboring counties, but they are given here to make them of general use. They are from the notes of Horace Horton, civil engineer, Rochester, who ran the lines on which the elevations occur. These elevations were referred to the level of low water in the Mississippi River at Wabasha. This is 30 feet below St. Paul and 620 feet above the surface of the ocean.

ELEVATIONS FROM THE NOTES OF HORACE HORTON, C. E.

	Above the Mississippi River at low water at Wabasha.	Above the Ocean.
1 Head of East Indian creek, 5 miles N. E. of Plainview, (Wabasha county.)	534	1,154
2 Street of Plainview (Wabasha county.)	518	1,138
3 Elgin, (Wabasha county.)	390	1,010
4 Near center of sec. 14, Haverhill	634	1,254
5 S. W. corner sec. 24, Haverhill, (Rock, seen some feet above.)	570	1,190
6 Base of Sugar Loaf, sec. 31 and 32, Haverhill	390	1,010
7 College street bridge, Rochester	340	960
8 Surface of water beneath	325	945
9 Summit of Lone Mound, section 11, Farmington, within 10 feet of Plainview level, viz.:	518	1,138
10 S. E. corner sec. 10, High Forest	667	1,287
11 Low water at High Forest village	570	1,190
12 Sec. 29, T. 104 N., 15 W., Mower Co., half mile south John Rowley's house	757	1,377
13 Dr. Thornhill's farm, 4 miles east Brownsdale, in Mower county	730	1,350
14 S. Minn. R. R. at Brownsdale, (Mower county.)	632	1,252
15 St. Paul and Milwaukee R. R. track at Austin, (Mower county.)	560	1,180
16 Chatfield, about	267	887
17 Pleasant Grove, about	667	1,287
18 Creek near the schoolhouse in sec. 15, Cascade, about	365	985
19 N. W. corner section 10, Cascade	500	1,120
20 Quarter stake, sections 33 and 34, Oronoco	490	1,110
21 Center stake, sec. 21, Oronoco	465	1,085
22 Surface of river at Oronoco	315	935

Lone Mound (elevation 9) is about 150 feet above the surrounding country.

Elevation 10 gives the summit of the water-shed between the Zumbro and Root Rivers. From section 5, Orion, to section 21, Rock Dell, the elevation of this water-shed does not vary 10 feet from the figures given. By comparing the figures in the table it will be seen that this water shed includes the highest land in the county of which we have any record of observations. A general elevation toward the south and southwest is visible. This elevation reaches its maximum in the counties south, which include in their borders the most elevated land in the State. On comparing the geological map of the county, accompanying this report, and the table of elevations, a striking relation between the altitude and ge-

ological formation is rendered manifest. This will be more particularly referred to under the heads of the individual formations.

Timber.—Heavy timber is found along the large streams, though it is pretty well cut out now. Aspen and brush thickets are common everywhere. The following trees, shrubs and twining plants were observed while driving through the county:

I. *Trees.*

Basswood (*Tilia Americana. L.*)
Sugar Maple (*Acer Saccharinum. Wang.*)
Red Maple (*A, rubrum. L.*)
Soft Maple (*A, dasycarpum. Ehr.*)

The first two maples do not usually attain any considerable size, while the soft maple, in a state of nature, becomes a large tree.

Box Elder (*Negundo aceroides. Mœnch.*)

This tree is common along streams and is a favorite in cultivation. In transplanting it is trimmed up too much to easily take root. It is a pretty tree, of pleasing form and full foliage.

White Ash (*Fraxinus Americana. L.*)
Slippery Elm (*Ulmus fulva. Michx.*)
Corky Elm (*U. racemosa. Thomas.*)

Of which I saw several trees along the streets in Rochester. It was undoubtedly transplanted from woods close by.

White Elm (*U. Americana. L. pl. Clayt. Willd.*)
Black Walnut (*Juglans nigra. L.*)

A grove of these trees was seen in Kalmar.

Butternut (*Juglans cinerea. L.*)
Hickory (*Carya.*)

Only very small trees were seen. It is said that they are always cut when young to make round barrel-hoops, such hoops having been taken to be characteristic of barrels containing Minnesota flour. It is a destructive and pernicious practice, for thus one of the most valuable of trees is prevented from maturing. The only way to prevent it is to make square hoops the fashion for Minnesota, which could easily be done by a combination of the leading millers.

Bur-oak, (*Quercus macrocarpa. Michx.*)

Is very abundant. On prairies it is low, 3–8 ft. high, forming extensive thickets and fruiting abundantly. In more favorable localities it is larger and may become quite a tree.

White-oak (*Q. alba. L.*)

Is hard to distinguish at a distance from the preceding. Undoubted specimens were seen near High Forest.

Jack-oak, Yellow-oak, etc., etc., (*Q. coccinea, Wang. Var. tinctoria.*)

Like all the species of this group of oaks, this tree is hard to identify. It is very common but is gradually disappearing before civilization. It is frequently seen dead or dying, without apparent cause.

Paper-birch (*Betula papyracea. Ait.*)

Small, along streams in the northern part of the county.

American Aspen (*Papulus tremuloides. Michx.*)

Very common, usually small.

Coarsely toothed Aspen (*P. grandidentata. Michx.*)

Cottonwood (*P. monilifera. Ait.*)

A great favorite in cultivation.

Balm of Gilead (*P. balsamifera. L.*)

Silver Poplar (*P. alba. L.*)

Lombardy Poplar (*P. dilatata. Ait.*)

The last three are introduced and are very common in cultivation.

Willows. Several species were seen, some of them becoming large trees.

White Pine (*Pinus strobus. L.*)

A few straggling specimens were seen on the bluffs three miles east Rochester.

Locust (*Robinia Pseud-acacia. L.*)

Is commonly cultivated. The same is true of several pines and spruces and a larch.

II. *Shrubs.*

Prickly Ash (*Zanthoxylum Americanum. Mill.*)

Smooth Sumac (*Rhus glabra. L.*)

Poison Ivy (*R. Toxicodendron. L.*)

False Indigo (*Amorpha fruticosa. L.*)

Lead Plant (*A. Canescens. Nutt.*)

Wild Plum (*Prunus Americana. Marshall.*)

Apparently several varieties, some of them producing the greatest abundance of pleasant fruit.

Wild Red Cherry (*P. Pennsylvanica. L.*)

Choke Cherry (*P. Virginiana. L.*)

Wild Black Cherry (*P. serotina. Ehr.*)

Nine Bark (*Spiraea opulifolia. L.*)

Common Meadow-Sweet (*Salicifolia. L.*)

Wild Rose (*Rosa blanda. Ait.*)

Wild Red Raspberry (*Rubus strigosus. Michx.*)

Wild Black Raspberry (*R. occidentalis. L.*)

Flavor of the fruit is said to be remarkably good.

Common Blackberry (*R. villosus. Ait.*) Not common.

Black Torn (*Cratægus tomentosa. L. Var. pyrifolia.*)

Black Thorn (*Cratægus tomentosa. L. Var. punctata.*)

Choke-berry (*Pyrus arbutifolia. L.*)

Am. Mountain Ash (*P. Americana. DC.*) Cultivated.

Eu. Mountain-Ash (*P. Aucuparia. Gært.*) Cultivated.

Red-osier Dogwood (*Cornus stolonifera. Michx.*)

Panicled Dogwood (*C. paniculata. L'Her.*)

Wolf-berry (*Symphoricarpus occidentalis. R. Br.*)

Sheep-berry, Wild Haw (*Viburnum Lentago. L.*)

Cranberry-tree (*V. Opulus. L.*)

Is frequently cultivated.

Hazel (*Corylus Americana. Watt.*)

Abundant on prairies.

Low Birch (*Betula pumila. L.*) Cold bogs.
Speckled Alder (*Alnus incana. Willd.*) Along streams.
Juniper (*Juniperus Sabina. L.*)
Seen only on a rocky bank on Root River—sec. 35. Rock Dell.

III. *Vines.*

Virgin's Bower (*Clametis Virginiana. L.*)
Frost Grape (*Vitis cordifolia. Michx.*)
Virginia-Creeper (*Ampelopsis quinquefolia. Michx.*)
Common wild and a favorite in cultivation. It is often erroneously called *Ivy.*
Shrubby Bitter-sweet (*Celastrus scandens. L.*)
Hop. (*Humulus Lupulus. L.*)
Wild and in cultivation.

THE GEOLOGICAL STRUCTURE.

The outcrops of rock are numerous throughout the county. It lies just at the edge of the system of deeply eroded valleys extending westward from the Mississippi. To the east of it are the deep ravines which cut through the high bluffs at the base of which the great river lies. The beds of these ravines gradually rise in receding from the Mississippi, and it is in Olmsted county that they rise to near the surface of the surrounding country. To the west and southwest of the county lies the great accumulation of drift which grows deeper and deeper as one passes westward. This material thins out over Olmsted. In the southwest corner it is thick enough to conceal entirely the rock-features below. Eastward it appears only in thin outliers, marking the ragged edge of deposition, or in patches and masses which are remnants left by subsequent erosion. In order to see to the best advantage the changes in the drift, features of erosion, and stratification, one must cross the county obliquely. There is t he least drift, generally speaking, in the northeast corner, and the most in the southwest corner. On the other hand, the southeast and northwest corners are much alike in the very feature in which the other two corners differ. In a rough way the lines of change cross the county diagonally in a southeasterly and northwesterly direction. This is due to two facts which may have some relation with each other. In the first place the Great River in the vicinity of the county runs in a generally southeast direction. The erosion-valleys extending from it would tend to take a direction perpendicular to it, and the lines of equal depth of erosion would tend to be parallel to it. Again, the dip of the rocks in this county is slightly southwest. The edges of the strata as presented on the surface would tend to be in lines perpendicular to this direction.

There are no signs of noteworthy upheaval, depression or other changes in the relations of the strata to each other in this county, as in the whole of this part of the state the strata are conformable. The peculiar structure of the bluffs enables one to trace some of the strata at a distance. As far as the eye can follow them their planes occupy the same position with reference to the horizon. The only exception to this is the Cretaceous. Its rather doubtful patches in the county lie in nearly a horizontal plane, and across the edges of the strata below.

The strata of the rocks other than Cretaceous do not lie in a horizontal plane. The dip is very slight, and in this county is toward the southwest. Toward the northwest corner the line of dip alters a little, and is more southerly. Comparison of altitudes and strata over a larger portion of the State has convinced Mr. W. D. Hurlbut that the dip here is 10 feet to the mile southwest. All my observations in the county tended to prove the correctness of this estimate.

The stratigraphy of this fine county is easy to read in most cases. The form of the bluffs, the line of springs making a definite part of the Trenton, the differing solubility of the rock and the consequent occurrence of sink holes, caves, etc., in one formation and not in another, the lithological character of the rocks notably distinct in some of the formations, and the gradual and regular dip of the strata, which, when taken with the erosion, enables one to predict with much certainty the rock over which he is standing, even when it is hidden from view—all these enable one to read the stratigraphical enigma of the county with little trouble. In this study the intimate knowledge of the county possessed by Mr. Hurlbut assisted me greatly. He cheerfully rendered me all the assistance in his power, besides hospitably entertaining me at his house. The stormy weather of the season devoted to this work prevented me from visiting all of the county. In such cases the details of the map accompanying this report were put in by Mr. Hurlbut. You yourself, sir, as director of the survey, have frequently passed through this county, and your observations in it have not only confirmed many of my own, but have added facts which escaped my attention.

I will here embrace the opportunity of recommending Olmsted county as an excellent field for teaching stratigraphy. The strata are interesting, the characters mentioned above make the reading of them easy, the scenery is unusually attractive. I can conceive of no better spot to which to take a class of students for instruction in geological field-work.

The formations found in the county are not numerous. The Potsdam sandstone is said to be found in the beds of the Zumbro and Whitewater rivers, about where t hey leave the county. It has not been seen by me, however, and the sandstone is probably only one of the lower sandstone layers of the Lower Magnesian. The latter formation, the St. Peter sandstone, the Trenton limestone and the Galena, are found here, the first and last probably only represented by a part of their entire thickness. A little Cretaceous was found.

THE LOWER MAGNESIAN LIMESTONE.

The AREA of this formation in the county is as follows. It follows the larger streams, beginning on them when well in the county, and broadening out until it leaves the county with them. It appears in the beds of the branches of the Zumbro well up in Rochester, Marion, Haverhill and Cascade townships. Rochester lies on a floor formed by the upper surface of this formation. The valley of Rochester city is entirely shut in by bluffs, except where the Zumbro passes out to the north and along a geological valley, now dry, to the northwest. This lower magnesian valley of Rochester city is somewhat crab-shaped, and is formed by the meeting of the various streams which make up this branch of the Zumbro. Cascade township is about half Lower Magnesian, the remaining surface being occupied by spurs and islands of the formations above, one of these islands being quite large. Oronoco township is almost exclusively Lower Magnesian. Farmington is of the Lower Magnesian floor, except the southern edge and some outliers of Trenton and St. Peter. In New Haven the middle fork of the Zumbro soon rises to the Trenton, while the north fork lies on the Magnesian, until it passes into the next county west. A large portion of Quincy is Lower Magnesian, as is a little of the northeast of Viola. An arm of this formation appears at the surface in the bed of the river, passing nearly through Dover from east to west. Elmira is also floored with Lower Magnesian for the most part, as is a small portion of Orion. The village of Dover lies in a Lower Magnesian valley, something like that of Rochester city. The same is true of Chatfield. Something more than 20 per cent. of the county has a floor of Lower Magnesian.

The *Lithological characters* of the formation here partake of its general characters in Minnesota as described by the Director of the Survey in his First Annual Report (for 1872, pp. 81–83.) It varies from a compact, fine magnesian limestone to a pure, friable, saccha-

rine white sandstone. It is frequently in irregular layers, which are not continuous for any distance. Sometimes these layers are thin and continuous; sometimes they are thick and cleave naturally into massive blocks. The rock is often brecciated, occasionally massive. Broken cherty layers, irregular silicious pockets, mottled sandstone, oolitic limestone, vesicular limestone, sparry cavities of considerable size, are all found in this variable yet usually easily recognized rock.

This rock holds its form well and thus produces characteristic *surface features*. When worn deeply into by erosion it presents bold cliffs and craggy, rounded hills. When not covered thickly by drift, it makes a poor surface for agricultnre, as may be seen in some parts of Oronoco. It is nearly barren, and is covered with scant grass, with hazel and scrub oak (in this case dwarf *Quercus macrocarpa*) or with small paper birch, and other wood-growth not large enough to be of importance economically. When this floor is covered by drift, as in the beautiful prairie township of Farmington, the soil may be unsurpassed. The most of this township is devoted to wheat, and at the proper season it seems to be one continuous wheatfield.

A *section* of this formation is seen at Quincy Mills. It is described in the First Annual Report, (for 1872) p. 82, and need not be repeated.*

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* *Note.*—As the report for 1872 is entirely out of print, the section at Quincy is hereby appended, in order to complete the geology of the county. No. 1 of this section is of the Shakopee limestone, and No. 2 is the upper portion of the Jordan sandstone.—N. H. W.

Descending Section at Quincy, Olmsted County.

No. 1. Dolomitic limestone; quite arenaceous, falling out in huge masses which are rough, distorted in their crude bedding, and unmanageable as a quarry stone, showing much calc-spar. Limestone and sandstone are mingled with occasional strips of light-green shale. In general the face presents the appearance of an alternation of horizontal layers of thin and more shaly beds, with heavy, coarse and rough limestone beds. Some green shale layers alternate with dark, umber-colored (ochreous) shale, neither being more than two inches thick. They are tortuous and not continuous. This phase appears like the tops of the bluffs at Winona, but is probably at a considerably higher horizon..... 30 ft.

No. 2. Persistent, white sandstone, or granular quartzite, seen.... 10 ft.

Total exposure ..... 40 ft.

The following section was taken at the lime-kiln of James Barnett, on section 8, Oronoco, just northeast of the village:

Calciferous sandstone, much broken, in thin layers, buff	14 ft.
Compact little broken calciferous sandstone, light buff	2 ft.
Sandstone (mostly saccharine) in layers	4 ft. 3 in.
Aluminous limestone, in thin layers, light buff	1 ft. 7 in.
Dark sandstone with numerous blue spots	1 ft. 8 in.
Arenaceous vesicular dolomite	3 ft. 6 in.
Like second above	4 ft.
Like second above, but more irregularly bedded	1 ft.
Vesicular, sparry, irregularly bedded dolomite	4 ft.
Total as far as seen	37 ft. 8 in.

The above section begins at the top. No fossils could be found. The lowest layer (last described) is employed by Mr. Barnett for making lime. The lime is light buff, slow, and contains considerable cement.

This lime is of considerable *economical value*. The lime of Barnett is good notwithstanding its slowness, and the cement in it only increases its value for many purposes. Mr. Barnett uses 12 cords of wood to one charge of his kiln. The wood costs $2.00 per cord. The kiln burns three days and affords 120 barrels of lime. Mr. Barnett says that the lime is slow in slacking, but that it sets quickly.

This rock does not furnish much good building material in this county. It is not of even bedding and homogeneous, texture generally. Pieces are sometimes employed at Rochester for window-caps and water-tables. These pieces are found only in the uppermost layers. No general use is made of them.

THE ST. PETER SANDSTONE.

The *area* of this rock is difficult to represent on a map. It is so friable that it will not endure erosion when left to itself. It is only when it is capped by the lower layers of the Trenton that it successfully resists the attacks of water. By itself, uncovered by other formations, it occupies but little space. It juts out beneath the cap of limestone only a few feet or rods. From a projecting spur of limestone it may extend farther, as is illustrated in the city of Rochester. A spur of Trenton comes in from the west and ends near the city limits. The sandstone, however, can be struck in sinking wells almost anywhere in the western portion of the city. Occasionally where erosion was incomplete an outlier of crumbling

sandstone can be seen, not capped by limestone. Such an outlier may be found in or near SW. Farmington. This must happen but rarely, and the outliers can attain but small size. Streams of considerable size usually leap from the Trenton to the Lower Magnesian, the intervening St. Peter sandstone having been washed completely away at an early period. Sometimes, however, streams of small size remain in a bed of St. Peter sandstone, in which case the valley is sandy, covered with small oaks, and worth little for agriculture. This is seen in the valleys of Bear Creek and its branches.

The *surface features* caused by the presence of this sandstone are interesting, and have already been referred to. As the incoherency of this formation deprives it of the power of resisting erosive forces, it is usually carried away cleanly wherever exposed. The consequence is a precipitous descent from the Trenton to the Lower Magnesian. This appears in lines of remarkable, level bluffs. The height of these bluffs is usually the thickness of the formation, with fifteen or more feet of limestone on the top. These bluffs are especially noticeable around Rochester. To the east their top is reached by a rugged ascent, to the west by gradual dip of the strata. The erosive forces have left many small and isolated bluffs, which can be properly described under this head, though the lower layers of Trenton limestone assist in their formation. They appear as rugged mounds rising from the Magnesian floor, and form a striking feature in the aspect of the neighborhood. They are most abundant in southwest Farmington and in Elmira. A few are seen along the railroad, just east of Rochester. Perhaps the most remarkable is "sugar-loaf mound," about two miles east of the city and close to the railroad. Its shape and relative proportions are those of a sugar-loaf. Another remarkable one is "Lone Mound," of section 11, Farmington. It is about three miles from the line of bluffs south. Two or three miles northwest are two similar mounds, called "Twin Mounds." They are in Wabasha county.

The thickness of the St. Peter was ascertained with an aneroid barometer, near Rochester. The upper layers of the Lower Magnesian were found on Bear Creek, near the woolen mills. The upper surface of the St. Peter was ascertained as carefully as might be near Whitcomb's quarry, and near Jenkins' quarry. Three comparisons were made. The proper allowance having been made for dip and atmospheric change, the value of 111 feet was obtained for the thickness of this formation.

The *lithological character* of the St. Peter is uniform and simple.

It is a rather coarse, white, friable sandstone, pure white, except where contaminated by foreign substances or percolations from the formation above. It contains no fossils so far as I could see in this county.

This formation is *useful* in several ways. When with a tight, magnesian floor, it holds water, and furnishes a good supply to wells. It is sometimes excavated where it comes out on the face of a bluff. Excellent cellars, dry and of uniform temperature, are thus formed which are used especially for the preservation of vegetables. It supplies an inexhaustible amount of pure white sand, round-angular, and excellent for mortar or glass-making.

THE TRENTON LIMESTONE.

As this formation lies next above the St. Peter, and as the dip is southwest, we should expect to find it just behind the sandstone. Such is the case, but being a coherent limestone it occupies much more *area* than the St. Peter. It covers fully one-half of the county, stretching in a broad, interrupted band from southeast to northwest. Its outer edge is the labyrinthine, interrupted line of level, peculiar bluffs which reach in their serpentine course every township in the county, except only Rock Dell and High Forest. The southwestern or upper edge of its outcrop can not be traced so minutely, as this formation passes insensibly into the Galena which overlies it. The formation covers the most of Kalmar, Haverhill, Viola and Eyota townships. It caps also with a few feet of limestone the most of the outliers of St. Peter already mentioned.

The *lithological characters* are described in the First Annual Report (already referred to) and need not be repeated.

In general, as seen in this county, we have, below, a shaly limestone, often presenting beds of blue limestone useful for building. This is more or less interrupted by shale and averages 15 feet thick. Above this is a bed of green shale more or less interrupted with limestone, and about 15 feet thick also. Above this we have 125 feet of yellow, or gray, harsh, magnesian limestone, in regular beds of varying thickness. In deep quarrying this rock also is blue.

Many sections of this rock can be seen. It is the rock most generally quarried. Several sections for Olmsted county are given on pp. 97–99 of the First Annual Report of the survey (for 1872.) The characters of others examined by me were uniform with those there described.

Many fossils are found in these beds. *Chaetetes Lycoperdon* is

plentiful in the green shale. *Leptaena*, *Orthis*, *Strophomena*, *Murchisonia*, *Pleurotomaria*, *Orthoceras* are common. The orthoceratites are unusually large.

This stone is the one most used in this county for building purposes. The stone for the buildings about Rochester were for the most part taken from the Trenton quarries near by. The quarry of W. Jenkins, just within the city limits, furnishes a large proportion of this stone.

It has been suggested that the clay of the green shale would make good brick or pottery. The grain is very fine, but the presence of small, calcareous fossils injures it for these purposes. A pottery factory, in which this clay was employed, started some years ago, had to be abandoned on this account.

THE GALENA LIMESTONE.

The *area* of this formation in the county is much less than that of the Trenton. It is found only in the southwestern part of the county, and covers rather less than 20 per cent. of the whole area. Byron, in Kalmar, is located on this rock. It underlies nearly all of Salem and High Forest, and considerable parts of Rock Dell, Rochester and Pleasant Grove. It extends into Marion and Orion, and Mr. Hurlbut tells me that a small scalp of it may yet be found in the western part of Eyota township. The lower and upper edges of its outcrop can not be accurately traced. In the case of the lower edge it is for the reason already mentioned, viz.: the Trenton and Galena blend gradually. The upper edge cannot be traced because it is completely concealed by drift.

In *lithological character*, as seen here, this rock is a heavily bedded, buff dolomite, fine grained, or coarse and porous. It contains often small pieces of iron pyrites, which, by weathering, give it ferruginous stains. Lead has not been found in place in the rock, but farmers sometimes find it isolated on the surface, evidently left behind when the rest of the rock material was weathered away. It often contains crystals of spar; sometimes irregular cavities are found. Under the influence of the weather the rock is seen to vary in solubility. The result is frequently sink-holes of varying dimensions Such holes, a few feet deep, are common on the bluffs of this formation, and I was informed by Mr. Hurlbut of an extensive one on the bluff near Garrick's quarry, the bottom of which has never been reached. Another result of this unequal weathering is the craggy appearance of the bluffs formed by the Galena.

This limestone is well displayed in this county at Garrick's quarry,

Sec. 17, Rochester township. The floor of this quarry is about 30 feet above the Trenton. To the top of the quarry is about 35 feet. The rock is a sparry, magnesian and more or less arenaceous limestone. It is in beds one to three feet thick, separated by very thin layers of light blue shale. The beds are massive and yellowish, somewhat stained with iron, arising from the decay of iron pyrites. The upper portions are most arenaceous and fossiliferous. In the crevices is found abundance of satin spar, and in the largest ones stalactites may be found.

R. Williams' quarry, on the north bank of Root river, Sec. 31, High Forest township, is in this formation. This rock is exposed for 25 feet, and is dolomitic, more or less concretionary, with small, spar-lined cavities. It is sparingly fossiliferous. The upper six feet are much broken up. The remainder is compact and unevenly bedded. The concretionary structure is not visible on fresh surfaces. It is brought out by weathering and especially by burning, and then appears in the form of fine rusty lines.

On the left bank of the same stream, about one mile west of Williams' quarry, is an exposure of yellow thin-bedded, broken, uneven, dolomitic limestone, of which only 8 or ten feet are visible. I found no fossils, but was sure, from the lithological characters, that the rock is Galena.

The same rock is well exposed in the ravines of Salem and Rock Dell, where it is quarried to some extent for building.

As to *economical value*, this formation produces the best building stone found in the State. It is much used in Rochester, but has been mostly derived from Mantorville, in Dodge county. It will be further described under that head. At Russell Williams' quarry, near High Forest, it is burned for lime. There are five kilns at this place. Each kiln takes 12 cords of wood for one charge of stone. The wood has to be brought from a distance, and costs at the kiln $6.00 per cord. Three hundred barrels of lime are burned in a kiln. The lime is white and fine, and has the best reputation of any lime hereabouts. It sells at $1.00 per barrel.

THE CRETACEOUS.

A careful search along Root River and elsewhere in the southwest corner of the county, failed to afford me the slightest trace of the Maquoketa shales, which would be naturally expected overlying the Galena. An outcrop was found a few rods west of P. Brewer's residence, in the southwest quarter of section 35, of Rock Dell

township, on the north bank of Root River, the character of which is doubtful. The formations in the adjoining counties, and the lithological character, indicate the probability of its being Cretaceous, and it is thus marked on the accompanying map. The exposure is along a road-track going down to a ford of the stream, and was partially covered with soil and overgrown by bushes. The following is the section from below upwards:

Compact, blueish limestone	2 feet.
Indurated, arenaceous, yellowish shale	1 foot.
Yellow sandstone, in broken layers	1 foot.
Light blue clay	½ foot.
Reddish, broken sandstone	1½ feet.
Light blue clay	¼ foot.
Sandstone	1 foot.
Sandy, bluish clay	½ foot.
Total seen distinctly	7¾ feet.

The same arrangement of alternating sandstone and clay could be traced indistinctly four or five feet farther up.

Three rods farther down the river is a compact limestone, siliceous, not dolomitic, non-fossiliferous, much broken by frost. The line of meeting of this with the preceding was concealed by soil and overgrowing plants.

The first described is in all probability Cretaceous; the second I am unable to refer to any formation with certainty. Perhaps it is Cretaceous, perhaps Niagara.

A scalp of Cretaceous, containing fossils in abundance, is said to have been found in the western part of Eyota township. It was of very limited extent.

THE DRIFT.

This covers much of the county. It thins out toward the northeast. It is of considerable thickness in the southwest. Its edge is ragged and shows extensions, which, however, are not in conformation with the present drainage system. It consists of blue clay, washed or yellow clay, stratified gravel and sand, and boulders.

The blue clay is by no means continuous. It is found in limited areas, and bands in various parts of the county. Sometimes it forms distinct ridges, as in western Rochester city and in the valley directly east of Rochester. In such cases it usually abuts on a bluff.

The washed clay, as its name indicates, has been worked over by

water since its deposition in the drift. It occupies low pond-like spots, or abuts on the bluffs. It is usually of a uniform reddish-yellow color and quite arenaceous. Sometimes it is in colored layers of red, yellow and green. In this case its derivation is probably from the green shale of the Trenton as well as from the drift. The washed clay is used for bricks.

The exposures of sand and gravel are not extensive in the parts of the county examined by me. Where seen they exhibit the usual characters. The boulders are entirely absent in most p arts of the county. In many scattered localities, again, they are abundant; and in the southwest corner of the county they are often found of great size.

The following table of wells will be useful for an analysis of the drift. The facts were furnished by O. Sprague, practical well-digger. Mr. Sprague is an observing man, and has probably dug more wells than any one else in the county:

Wells in Olmsted County.

O. SPRAGUE.

Location.	Owner.	DEPTH IN FEET			Water.	Remarks.
		Drift.	Rock.	Total.		
35. Farmington ...	C. E. Stacy.	22	31	53	Good.	5 feet black soil; then reached clay.
35. Farmington....	W. H. White.	20	24	44	Good.	Yellow clay and blue rock.
36. Farmington....	E. Raymond.	11	..	11	Good.	Blue clay.
25. Farmington....	W. Searles.	44	..	44	Good.	14 feet black heavy soil; remainder blue clay.
30. Haverhill	J. P. Simonds.	25	10	35	Soft.	25 feet sand; 10 feet hard sand rock.
9. Haverhill	P. H. McGovern.	40	50	90	Good.	Red, hard drift.
32. Haverhill	J. E. Brown.	25	..	25	Good.	4-5 feet soil, then sand.
11. Haverhill	B. F. Bulen.	12	..	12	Plenty.	Red, hard drift.
14. Salem	Z. Holt.	25	..	25	Good.	Sand all the way.
14. Salem	J. D. Fuller.	40	..	40	Good.	Sand all the way.
26. Salem	J. P. Fosdick.	30	6	36	Soft.	White, hard rock.
21. Salem	Ole Severson.	27	..	27	Good.	Sand.
16. Salem	C. Peterson.	25	..	25	Good.	Sand.
16. Salem	Nils Jacobson.	25	.	25	Good.	Sand, foot of bluff.
16. Salem.....	T. Thomson.....	57	16	73	Good	Red, hard drift; white limestone.
28. Salem.....	.....	32	..	32	Good.	20 feet blue clay.
30. Pleasant Grove.	Fred. Sibeck.	61	..	61	Good.	48 feet blue clay.
29. Pleasant Grove.	J. Collins.	21	..	21	Good.	15 feet blue clay.
25. Pleasant Grove.	D. W. Hymes.	20	40	60	Good.	Sandy, red clay.
11. Cascade.....	T. C. Cumings.	30	..	30	Plenty	25 feet blue clay.
17 Cascade.....	J. H. Hodgman.	25	..	25	Plenty.	Sand.
17. Cascade.....	E. Babcock.	25	..	25	Plenty.	Sand.
15. Cascade . ..	P. Boardman.	30	..	30	Plenty.	Red, sandy clay.
15. Cascade.....	J. Gardner	30	..	30	Plenty.	Red, sandy clay.
15. Rochester.....	I. M. Westfall.	40	..	40	Plenty.	Sand.
2. Rochester.....	W.L.Brackenridg	18	..	18	Plenty.	Sand.
5. Viola.....	D. D. Whipple.	44	50	94	Plenty.	

Cedar logs at considerable depths in the drift are found but rare-

ly. Mr. Sprague says they are always under the blue clay. Rotten wood is occasionally found in the blue clay.

It is a striking fact, often mentioned, that water is often found on the bluffs at a much less depth than at their base. The geological formation satisfactorily accounts for this.

Brick are made at many places in the county. Oronoco, Eyota, Pleasant Grove and Byron furnish brick. The most of them are made at Rochester. E. P. Brown burns 350,000 a year. Whitcomb Bros. burn, as they tell me, 1,200,000 brick per year, in five or six kilns. The brick here and at Brown's are machine made. V. Whitcomb has a small brickyard near that of Whitcomb Bros. In all cases coming under my observation the brick are made from the washed clay. This is in beds from two feet to ten or twelve feet or more. Although this material is sandy, more sand is usually put in in making the brick, which are consequently tender, and of poor quality. The brick vitrify but little when burned.

No peat was observed in the county. In some lowlands the turf is thick and comparatively free from inorganic matter. This will burn and produce some heat, but it is much inferior to proper peat. I saw no peat-bogs nor any extensive accumulations of peat-producing plants of any kind in the county.

GOLD has been found in the drift along the Zumbro from Rochester and Oronoco down to the Wabasha border and beyond. It is found only on the Lower Magnesian. Murchison calls attention to this fact as generally true. It is found in the drift about the stream, but mostly in the bed of the stream or in material worked over by it at a comparatively recent date. In the same alluvial material is found a small amount of black sand, of a specific gravity approaching that of gold. When the gold is obtained by washing, after all the other materials are washed away this heavy black sand remains, and the minute fragments of gold are picked out from it. It is therefore here called the "mother of gold," and the two are thought to be always together, a conclusion which need not necessarily follow.

The gold is in minute, angular fragments. The quantity is so small that it does not pay to work it by the ordinary method of hand-washing. Washing on a more extensive scale might be made to pay. It has been tried two or three times, but never under favorable circumstances, or for periods of any length. It remains yet to be seen whether it will pay or not.

It may be worth while just here to call attention to the fact that gold is frequently found under these circumstances. It has been

found over extensive regions in Canada, where attempts at obtaining it on a large scale have always failed to pay. I have heard of it in Vermont, Ohio, Wisconsin and Iowa. The Director of the geological survey reports it from several places in Minnesota besides this, i. e., in Fillmore county, at Jordan, in Scott county, etc., etc. From all these facts the conclusion may be drawn that the prospects of its paying in Olmsted county are not good.

GEOLOGICAL MAP OF DODGE COUNTY,

BY M. W. HARRINGTON 1875

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

Explanation

- Galena
- Trenton
- St. Peter
- Shakopee
- Marsh
- Timber

GOODHUE CO.

WABASHA CO.

DODGE CO.

OLMSTED CO.

FILLMORE CO.

MOWER CO.

ELLINGTON

CONCORD

MILTON

CLAREMONT

WASIOJA

MANTORVILLE

RIPLEY

CANISTEO

WESTFIELD

HAYFIELD

VERNON

KASSON

DODGE CENTER

CLAREMONT

CONCORD

BUCHANAN

WASIOJA

MANTORVILLE

Ellington P.O.

E. Claremont P.O.

RICELAKE

Vernon P.O.

Othello P.O.

MIDDLE FORK OF ZUMBRO RIVER

T 106 N.

T 105 N.

R XVIII W.

DODGE COUNTY.

BY M. W. HARRINGTON.

This county lies immediately west of Olmsted county. Its form is that of a rectangle. It is a small county, having four townships in a north and south direction, and three in an east and west. Its area is as follows. This table is taken from the office of the State Auditor, Hon. O. P. Whitcomb:

AREA OF DODGE COUNTY.

Name of Township.	Township.	Range	AREA IN TOWNSHIP. Acres.
Vernon	105	16	23,057.39
Canisteo	106	16	23,111.88
Mantorville	107	16	23,054.88
Milton	108	16	22,964.09
Hayfield	105	17	24,123.22
Ashland	106	17	24,123.40
Wasioja	107	17	24,081.86
Concord	108	17	24,233.99
Westfield	105	18	23,030.33
Ripley	106	18	23,008.72
Claremont	107	18	22,898.42
Ellington	108	18	22,950.72

The total area is 280,638.90 acres, or nearly 438½ square miles. In addition to this, Rice Lake covers 61 acres in this county.

Drainage.—The water flows, for the most part, to the east and northeast by means of the branches of Zumbro River. The largest

of these branches is the South Branch of the Middle Fork of the Zumbro, which rises in Rice Lake, on the western border of the county, and flows eastward through nearly the central portion. The north branch of the same stream has its source in the wet prairies in the northwest corner of the county and flows nearly eastward also. The south fork of the Zumbro reaches this county by two small branches which have their sources in the southeastern part. Cedar River enters near the southwestern angle of the county. It drains Westfield and a part of Hayfield. The fall of the streams is inconsiderable in all parts of the county, but is greater in the northern part of the county than in the southern.

Rice Lake lies partly in this county, partly in the county next west.

Water Powers.—Two streams only furnish them in this county. These are two branches of the Zumbro, both branches of middle fork. The following is the list of these powers:

Mills.	Owner.	Location.	Stream.	Head Feet.	Stone. Run.	Kind of Mill.
Wasioja.....	A. Mason & Son..	Wasioja Village	Middle Fork.	9	4	Cus. & flour.
Blake's.....	J. D. Blake.... ..	Sec. 13, Wasioja	Middle Fork.	12	4	Flouring.
Mantorville..	Adams & Kneeland	Mantorville Vill	Middle Fork.	10 / 7	3	Custom.
Rockton.....	John Bradford.....	22, Mantorville.	Middle Fork.	8	2	Cus. & flour.
Agawam.....	Chase & Swaringan	13, Mantorville.	Middle Fork.	12	2	Flouring.
Eagle Valley.	J. Gordon.....	15, Concord ...	North Fork..	12	2	Custom.
Buchanan ...	Widow Irish.	Buchanan Vill..	North Fork..	10	...	Saw mill.
Milton.....	James Elias.....	9, Milton	North Fork..	8	2	Custom.

Of the above mills that at Mantorville has two powers, one about 110 rods below the other. Agawam Mills is the latest name for what has been called Dodge County Mills and Bunker's Mill. An unimproved mill-privilege was found at Concord. The Middle Fork of the Zumbro rises in Rice Lake. This lake also has a natural outlet toward Straight River on the west.

In order to give the mills just enumerated on the Middle Fork as much water as possible the western outlet to the lake has been cut off. Yet for three or four months in the winter of 1874–5 the mills had no water. Some years, however, they continue to have water the year through. The water in the North Branch is even more unreliable than this.

The *surface* is but little diversified. The southern and southwestern part of the county is prairie-land. In the northeastern portion bluffs of some hight are found along the streams. The southwestern part of the county is marshy and thinly settled. The region around Rice Lake is also low and marshy.

The plats of the government surveys were examined in the office of the county register and the following notes were made:

Vernon (105, 16) contains considerable grub-land and a small thicket. The remainder is all prairie. The magnetic variation is from 8° 20′ to 9° 06′.

Canisteo.—(106, 16.) A few acres of marsh and a small pond are found in this township. About two-ninths of the township is set down as brush land. The remainder is prairie. Magnetic variation, 8° 26′ to 9° 0′.

Mantorville.—(107, 16.) This township has a small marsh laid down about 40 acres in extent. A considerable portion of the township is pretty heavily wooded, especially along the streams. Magnetic variation, 7° 24′ to 9° 10′.

Milton.—(108, 16.) A small marsh of 25 acres is platted. The northern half is mostly wooded. The southeastern part is wooded, and isolated groves are found on the remainder. On the portions marked prairie are often found notes of "barren thickets," "barrens," "scattering timber," &c. Magnetic variation, 6° 45′ to 10° 0′.

Hayfield.—(105, 17.) It is but little wooded, only about 16 per cent. The remainder is prairie. Magnetic variation, 7° 40′ to 8° 55′.

Ashland.—(106, 17.) A pond of about 10 acres is found on the eastern line of section 25. About one-ninth of the township is wooded. Magnetic variation, 7° 55′ to 8° 50′.

Wasioja.—(107, 17.) A small marsh of about 160 acres is laid down in sections 8 and 9; also a patch of wet land of 240 acres in the western part of the township. Wood follows the main stream, and a few scattering patches are found elsewhere. The remainder is prairie. Magnetic variation, 7° 22′ to 8° 30′.

Concord.—(108, 17.) Eight small marshes varying from 8 to 40 acres are platted. Some woods but mostly open. Magnetic variation, 6° 25′ to 8° 47′.

Westfield.—(105, 18.) Three marshes from 50 to 320 acres each are recorded. A little wooded land is also present. The remainder is prairie. Magnetic variation, 7° 24′ to 8° 19′.

Ripley.—(106, 18.) A stream terminates in a marsh of 100 acres in section 4. The same is true of a long one near the northeast corner. In addition to these 15 marshes are laid down. They vary from 10 to 320 acres. Some wood is found but the township is mostly prairie. The magnetic variation varies from 7° 10′ to 8° 15′.

Claremont.—(107, 18.) Besides the marsh around Rice Lake,

there are 8 small marshes varying from 5 to 60 acres. A band of wood runs through the township diagonally from the northwest, and two or three other small patches of wood are laid down. The magnetic variation varies from 7° 5′ to 8° 15′.

Ellington.—(108, 18.) A good many patches of marsh and wooded land are scattered over the township. Magnetic variation, 6° 48′ to 7° 56′.

TIMBER.

Heavy timber is found here as elsewhere in this part of the State along the streams. The list of plants would be nearly identical with that of Olmsted county. I will, therefore, give two lists, viz.: 1.—The plants seen in Dodge and not in Olmsted county. 2.—Plants seen in Olmsted and not in Dodge county.

1. Woody plants seen in Dodge but not in Olmsted county:

Moonseed. (*Menispermum Canadense. L.*)
Jersey Tea. (*Ceanothus Americanus. L.*)
Hawthorn. (*Crataegus coccinea. L.*)
Hawthorn. (*Cr. Crus-galli. L.*)
Wild Gooseberry. (*Ribes Cynosbati. L.*)
Large-leaved Dogwood. (*Cornus circinata. L'Her.*) Found in cold woods and bluffs.
Green Ash. (*Fraxinus viridis. Michx.*)
Sugarberry. *Celtis occidentalis. L.*)
Hop Horn-Beam. (*Ostrya Virginica. Willd.*)
Yellow Birch. (*Betula excelsa. Ait*)
White Pine. (*Pinus Strobus. L.*) A few straggling specimens were seen in Olmsted county. There is a grove of the trees near Mantorville.
Balsam Fir. (*Abies balsamea. Marshall.*) With the preceding.
Common Juniper. (*Juniperus communis. L.*)
Red Cedar. (*J. Viginiana. L.*)

2. Plants found in Olmsted but not in Dodge county:

Poison Ivy. (*Rhus Toxicodendron. L.*)
Corky Elm. (*Ulmus recemosa. Thomas.*)
Hoary Alder. (*Alnus incana. Willd.*)

It does not follow, by any means, that because I did not find the plants given above from one county in the other, they do not grow there. These lists are the results of observations hastily made as I drove through the counties. Many woody plants undoubtedly escaped me.

GEOLOGICAL STRUCTURE.

The outcrops of rock in this county are confined to the northeast portion. Canisteo, Mantorville, Milton, Concord and Wasioja townships include them all. Over the remaining seven townships the drift conceals every feature of the rock below. All the evidence that there is indicates that to some extent, at least, the rock so covered is Cretaceous, but I know of no facts of observation to demonstrate this.

The lowest formation found in the county is that of the *Shakopee Limestone.* This rock is known to enter the county from Olmsted, along the north branch of the Middle Fork of the Zumbro. For a distance of about 2¼ miles into the county is found the characteristic arrangement of bluffs surrounding a level valley. These bluffs are usually abrupt and approach much nearer to the north river bank than to the bank on the south. In several places in the bluffs the St. Peter Sandstone was actually observed. So that, though no Shakopee rock was actually seen within the limits of the county, the conclusion is a safe one that it does actually form the floor of the valley designated on the accompanying map.

Surrounding this valley is the bluffy outcrop of the *St. Peter Sandstone.* The structure of the bluffs gives a sure indication of its presence. Besides, as noted above, the rock was actually seen in several places. It was sometimes thrown out in digging wells, and occasionally appeared at the side or in the bed of the road. It preserved its characteristic lithological character of a white, friable sandstone, growing reddish and attaining more consistency when exposed to the air.

The remaining exposures of rock along this stream are *Trenton Limestone.* In descending the stream everything is covered by drift until we reach the vicinity of Eagle Valley Mills, section 15, of the township of Concord. Near here a rock, in rather thin layers, is quarried. The quarries are on the surface, and no good exposure of the rock is found. It is, however, without doubt, Trenton stone. Two miles farther down the stream is a quarry on the south bank, at the village of Concord, (N. W. corner of sec. 23.) Here is a pretty good exposure with the rock as follows, beginning above:

4 ft. black loam and reddish clay.
2½ ft. rubble stone.
3 ft. of dolomitic rock, yellow, with fine reddish lines; layers broken 2–8 in. thick.
3 ft. of bluish stone, less dolomitic, in even beds 1–2 ft. thick.
1 ft. of bluish stone, not dolomitic in thin layers.
3½ ft. of heavy layers of bluish stone, not dolomitic.

17 ft. total exposure.

Below this is a compact limestone, not well exposed. It is not dolomitic and is good for burning.

At the sawmill near the middle of sec. 17, of Milton, the road passes around an exposure of rock. Here are about 10 feet of shaly limestone and blue clay. A fine specimen of *Receptaculites* lay in the wheel-track of the road, and had been considerably marred. Many other incomplete specimens were found.

An eighth of a mile below this saw mill, (still in sec. 17 of Milton,) is an irregular bluff on the south side of the stream. It is concealed by debris, bushes, etc., and not very accessible. The following measurements and observations were obtained with as much accuracy as circumstances would admit. They are taken from above:

10 ft. of yellowish limestone in thin layers.
1 ft. of compact aluminous layers in 2 or 3 layers.
15 ft. of shale, limestone and blue clay in alternate layers, usually thin.

Below, passing under the debris and probably occupying the present river-bed is a thick stratum of compact limestone, with a depth of upwards of 20 feet. *Receptaculites* are abundant in the rock.

As might be anticipated from the structure of the rock, living springs are abundant along these bluffs. One very fine one, the size of one's arm, pours out from the rock just above the sawmill, at a distance of 20 feet above the water of the stream. Here these springs are almost equal in numbers in bluffs facing north or south, betraying the absence of dip at this point in either of those directions.

Other small exposures of Trenton rock were seen in the road in several places within the Trenton area as marked on the accompanying map, as at sections 19 and 30 of Milton township, and in sections 12, 13 and 14 of Mantorville. The lower parts of the exposures at Mantorville and Wasioja are, in all probability, Trenton, but as it is impracticable to tell where this rock begins, and

the rock above ceases, these exposures will be described under the Galena. The Trenton can also be traced into this county from Olmsted, in sec. 14, Canisteo.

The *Galena Limestone* is found cropping out along the South Branch of the Middle Fork of the Zumbro, or the Mantorville stream. In descending this stream no rock is found until in sec. 14, and the first important quarry is that of Thomas Arnold, on the north bank of the stream in sec. 13 of Wasioja. At the top of the exposed wall is a layer of 5 feet of rubble stone. Below this are 30 feet of dolomitic sparry stone, yellow when weathered, blue within. It is in evenly bedded layers, 6 in. to 3 ft. thick. It works smoothly and is soft, without flint. Near the bottom the rock was gray when weathered.

A few rods below this, on the same side of the stream, are the lime kilns of James Paul, two in number. This is in the village of Wasioja, in sec. 13. The rock, of which he has 8 or 10 ft. exposed close by, is yellow and in thin, rather irregular fragments. It is in all probability Galena. Mr. Paul obtains from this a lime of a light yellow color. He burns about 840 bbls. per year, for which he obtains $1.00 per barrel. He uses for this 86 cords of wood for which he pays $4.00 per cord. Mr. Paul praises his lime highly, and it is acknowledged on all hands to be good for laying stone. It is, however, generally said to be slow in slacking and not strong.

Blake's Mill is on the eastern edge of sec. 13 of Wasioja. At this place is an exposure of about 30 ft. of rock where materials have been obtained for the mill and dam. The upper 5 ft. are of broken rubble stone. The remainder is in solid, even beds, 6 in. to 3 ft. thick. The stone is a limestone, yellow, dolomitic, compact, coarse-grained.

About half a mile above Mantorville, in section 17 of Mantorville township, is a natural exposure of about 40 ft. of rock, on the north bank. The upper 20 ft. are composed of a compact rock in thick beds, yellow in color, wearing away very evenly by weathering, in a castellated manner. Below it the rock wears much more unevenly and is grayish. Between the two lies a thin soft layer which was not accessible. It wears out much more rapidly than the other rocks. It is probably a clay-shale. About 20 yards from this place is a fine spring, always flowing. It is caused by a layer of green shale lying just below it.

In the bed of the stream, just below the first dam at Mantorville, sec. 20, is a compact, dark limestone in thin beds and not dolomitic.

Just below, in the village of Mantorville, are the quarries of Chas.

Ginsberg and of Willson and Hook. The sections here were described in the first annual report, pp. 99. They have not changed appreciably in that time and the sections need not be repeated. Just below Willson and Hook's quarry is that of Peter Mantor. From the stone in Ginsberg's quarry, his brewery, hardby, was made. It is one of the finest buildings in this part of the State. From the stone in the other quarries were made, the facings of the Court House, Schoolhouse and Cook's Hotel in Rochester; the public buildings and many of the stores at Mantorville; many railroad bridges along the Winona & St. Peter, the highway bridge at Owatonna, etc. The stone is especially prized for the following reasons:

1. It is evenly bedded and can be got out in good shape.
2. There is little grit or flint in it to take off the edge of tools. It therefore works easily.
3. It hardens after exposure.
4. The color is yellow or light blue and is pleasing.
5. There is little iron in it to cause discolored spots. Two or three such spots are seen in the Court House at Mantorville. The iron on weathering makes a rusty blotch on the surface of the stone. These ferruginous spots can be easily detected beforehand, and rock containing them should not be used for the outside.

Mantor's quarry lies on both sides of the stream. That on the north side is quite similar in rock and strata to that of Willson and Hook, described by Prof. Winchell. That on the south side of the stream, opposite and a little below the other, has the following section taken from above:

2 ft. of loose material, broken rubble stone.
1 ft. light yellow rock in layers 3 in. thick.
4½ ft. of yellow dolomitic rock in thick beds.
½ ft. of shaly, yellow rock, including a layer of 2 inches of an uncemented rather fine gravel, containing numerous black quartzite pebbles.
4 ft. yellow dolomitic rock, in thick beds.

12 ft. total exposure.

In the bed of the race at the second dam at Mantorville, 110 rods below the mill, sec. 21, is a fossiliferous green shale.

At Rockton Mills, sec. 22, Mantorville, is a considerable exposure. This section is given at p. 100, in the First Annual Report, under the head of "Section at Pettit's Mill." In secs. 14, 15, 21, 22, 23, occasional exposures, usually slight, were seen.

From the facts stated above, as well as those stated by Prof. Winchell, in his first annual report, the conclusion has been drawn

that the Trenton occupies the bed of the stream as high as Wasioja, but that the bluffs are capped by Galena. This is the explanation of the long arm of blue color along the stream on the accompanying map.

Drift.—This covers nearly the whole county. Boulders are abundant and sometimes very large. Blue clay is said to underlie the whole of the southern and western part of the county. It lies at the depth of 10–30 feet, where it is always met in digging wells. Logs are sometimes found in it.

On the railroad betwee n sections 32 and 33 of Wasioja the water washed out a ditch to a considerable depth so that the following section could be made:

2 ft. of black loam above.
6 ft. of yellow sandy clay with some small pebbles below.
4 ft. to bottom, alternations of thin ferruginous sandy films and black or yellowish sandy clay.

12 ft. total.

In the bottom of the ditch was a bluish quartzite bolder, 15 in. across, and 6 in. thick, worn off smoothly on one side by glacial action. The smooth side was polished, but scratched.

At the crossing of the railroad over the stream a similar section, 15 feet thick, was found. It was similar to the above except that the bottom clay was dark blue and without the ferruginous films. In this clay were numerous drift-pebbles; among others a piece of Galena limestone.

The boulders are numerous and usually granitic, syenitic or quartzose in character. In the railroad cuttings in Wasioja township, some ferruginous concretions of small size and much decayed, many fragments of Galena limestone and a solitary piece of argillite were found. Careful search was made for traces of the Maquoketa shales but they were not found.

Brick are made by Wm. Gutherless at Dodge Center. He makes 200,000 per year. They take 75 cords of wood at $2.75 per cord. The yellow or washed clay is employed. Mr. Gutherless puts in about one-third sand which keeps the brick from checking and warping. The bed of clay is worked for a thickness of 3 or 4 feet.

Three miles west of Dodge Center, Mr. Taylor made 222,000 brick last year. They are from the same clay. In a brick building which had been standing barely a year, quite a number of these brick had begun to crumble.

G. F. Rhodes, of Kasson, makes brick from a reddish washed clay obtained from a bank in the village of Mantorville. He makes about 600,000 brick per year. A kiln contains 120,000 and takes 40 cords of wood at a cost of $4.00 per cord. The brick sell at $7.00 per thousand. No sand is put in the clay, and the brick are machine pressed. The brick are tender, like others made from washed clay, except when the burn is exactly right.

The clay in the bed used by Mr. Rhodes varies in the amount of alumina. From the richest clay he has made a batch of drain tiles. They are tough and have the characteristic color of such tiles. He makes three sizes which he sells as follows:

2 inch bore at	$15 00 per thousand.
3 inch bore at	17 50 per thousand.
4 inch bore at	20 00 per thousand.

In sec. 17 of Milton Township, Jacob Baumgartner has a kiln in which he occasionally burns *lime*. I was unable to see either lime or quarry, but the former is said to be whitish and the stone is evidently Trenton Limestone.

In sec. 10 of Milton Township, N. Irish has a kiln in which he burns lime. The stone is a bed of Travertine, light, porous and soft, apparently 3 or 4 feet thick. The bed is at the base of a small knoll and seems to have been deposited by a spring now running over the bed, though Mr. Irish claims that this spring now produces soft water. I was unable to ascertain the extent of the bed. One hundred and forty barrels of lime are burnt in one kiln, which takes 6 cords of wood, at $1.50 per cord. The lime sells at $1.00 per barrel at the kiln. Thirteen kilns a year are burned. The lime is very white and quick.

Explanation

Cretaceous
Trenton
Marsh
Timber

GEOLOGICAL MAP OF STEELE COUNTY.

BY M. W. HARRINGTON
1875

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

RICE COUNTY

R21W. R20W. R19W.

T108N T107N T106N T105N

OVERTON MEDIAPOLIS

DEERFIELD MERTON

CLINTON FALLS

POND

WINONA & ST PETER R. R.

MERIDEN OWATONNA HAVANNA

CHICAGO, MILWAUKEE & ST PAUL R. R.

LEMOND DEANT AURORA

STRAIGHT RIV.

BERLIN SUMMIT PRAIRIE BLOOMING

WASECA COUNTY

DODGE COUNTY

FREEBORN COUNTY

STEELE COUNTY.

BY M. W. HARRINGTON.

Position and size. This county lies in the second tier of counties from the Iowa line. It lies next west of Dodge county, being the fourth in number west from the Mississippi river. It has the form of a rectangle, and is bounded on the south by Freeborn, on the west by Waseca, and on the north by Rice counties.

The name, position and size of the townships are as follows. The figures were obtained from the office of the State Auditor, Hon. O. P. Whitcomb, with some additions from the office of the county register:

Position and Area of the Townships.

Name.	T.	R.	Acres & Hundredths.
Blooming Prairie	105	19	22,621.83
Aurora	106	19	22,964.93
Havanna	107	19	22,254.04
Merton	108	19	22,901.48
Summit	105	20	22,982.43
Somerset	106	20	23,001.47
Owatonna	107	20	22,912.82
Clinton Falls	108	20	11,446.00
Medford	108	20	11,433.57
Berlin	105	21	22,805.78
Lemond	106	21	23,005.80
Meriden	107	21	22,798.25
Deerfield	108	21	22,326.99

The total number of acres of land are seen to be 273,455.39. In addition to these there are about 428.66 acres of lake in Blooming Prairie; 676.33 in Havanna; 182.30 acres in Berlin; 144.46 in Meriden; 601.79 in Deerfield. The total lake area in the county

is thus made 2,033.54 acres. Adding this to the acres of land, we have 275,488.93 as the total acreage in the county.

Surface.

This county is quite level, and is covered heavily by drift. As will be seen the rock appears at the surface only along the Straight River, near its exit from the county. Grassy swales are common and characteristic of the swamps, especially in Lemond township. Gravelly knoles are quite common in the most of the county, especially in the southern part. They are short and steep in the south part of Somerset and the adjoining parts of Summit and Blooming Prairie. A long straight ridge with many boulders runs nearly on the township line between Aurora and Somerset. The southern part of the county is called the Wilderness and is not thickly settled. The level of the Milwaukee and St. Paul Railroad has been already published. The writer has been unable to get access to that of the Winona and St. Peter Railroad.

The following notes were taken from the field-notes and plats of the government survey in Steele county, access to which was obligingly given me by the County Register. The surveys were made in 1854.

Blooming Prairie, (105, 19,) was covered by thickets and low scrub for the most part. Marshes were numerous and there were two small lakes in the northern part of the township. Magnetic variation, 8° 10′ to 9° 45′.

Aurora.—(106, 19.) This township much resembled the last; thickets and scrub over the most it and numerous marshes, some of them quite large. Magnetic variation, 7° 45′ to 9° 45′.

Havanna.—(107, 19.) This township contains the major part of Rice Lake. It is for the most part brushy or wooded, but the southwestern part is prairie. Marshes are numerous but not large. Magnetic variation, 7° 44′ to 9° 25′.

Merton.—(108, 19.) This township was found to be wooded on the south side and in the northwest corner. The remainder was prairie. A large marsh was located in sections 23 and 24, and many smaller ones were scattered over the county. Magnetic variation, 7° 37′ to 9° 23′.

Summit, (105, 20) was wooded in the eastern half, prairie in the western. A large branching marsh is located along the streams, and there are a few isolated marshes. A stream from the south loses itself in the southwest corner of section 20. Magnetic variation 9° 18′ to 10° 23′.

Somerset (106, 20) had several sections of prairie in the northeast corner, and the portion of the township lying west of the Straight River was prairie; otherwise it was wooded. The marshes platted are few and not large. Magnetic variation, 9° 13′ to 10° 45′.

Owatonna, (107, 20.) A band of woods, 2-5 miles wide, crosses the township accompanying the Straight River, and lying on its eastern bank The remainder is prairie. The banks of the stream were bluffy. Magnetic variation, 9° 10′ to 10° 45′. The site of the city of Owatonna was already in part claimed when the survey was made (1854.)

Clinton Falls (south half of 108, 20) was mostly wooded, though a wedge of prairie lay between the Straight River and Crane Creek. There was also a little prairie on the eastern border. There was a long marsh platted in sections 26 and 27. Magnetic variation, 9° 10′—10° 30′.

Medford.—(north half of 108, 20.) This township is prairie, except for a wooded strip 2–4 miles wide, east of the river. The banks of the stream are rather bluffy. The claims of Sanburn, in section 16, Collings and Johnson, in 9, and Wright, in section 5, were already made. Magnetic variation, 8° 35′ to 10° 30′.

Berlin, (105, 21,) was wooded through the center of the township; the remainder was for the most part prairie. The plats indicate marshes along the streams, and some other scattered marshy spots. Near the center lie Looigana and Beaver lakes, and in the southwestern part a pond. Beaver Lake is now said to be deep and clear, and to contain only soft water. This item, and much other valuable information concerning this county, the writer owes to Rev. G. C. Tanner, superintendent of schools for the county. Magnetic variation, 8° 45′ to 10° 34′.

Lemond.—(106, 21.) The northwest part was woody and marshy, and there are besides two or three isolated groves of small extent. An extensive marsh crosses the north end of the township. Magnetic variation, 10° 00′ to 11° 13′.

Meriden.—(107, 21.) This township was nearly all prairie, a little wood being found north of Crane Creek and also a small amount in the southern part. The land along the creek was marshy. On the northern boundary a small lake was found. Magnetic variation, 10° 22′ to 11° 30′.

Deerfield.—(108, 21.) A lake enters from the south. Another of about 220 acres is platted just northeast of this, and near it is a pond of about half the size. All the township was wooded except the northwest corner, which was prairie. Extensive marshes were

platted in the southern and western part. Magnetic variation, 9° 30′ to 11° 40′.

On comparing the magnetic variations given above, it is found that the extremes are 7° 37′ in Merton, and 11° 40′ in Deerfield, being a variation of more than 4° in one small county.

Drainage.

This county is well provided with lakes, as may be seen in the preceding notes. Marshes also are numerous. These are due to the level character of the country, and to the very slight elevation of one part above another. The small amount of the elevation is further shown by the sluggishness of the currents in the various streams. The course of the Straight river shows that what elevation there is in the county, its increase occurs as we travel southward. But, although the county is very nearly level and has little change in elevation within itself, its elevation with reference to the rest of the State is considerable. This is shown by the fact that two streams origninate here, viz.: the Straight river, in the southern part of the county, and a branch of the Zumbro in Rice Lake. It is worthy of remark here, though it was mentioned in the report on Dodge county, that Rice Lake has a natural outlet into the Straight river as well as into the Zumbro.

The small amount of fall of the streams limits the mill privileges in this county. The mills are found only on the Straight River, at Owatonna, and north.

The City Mills at Owatonna, Drought & Whitson, owners. They have 7 feet head of water, and three run of stone. It is a custom mill, but does a little flouring business.

Clinton Mills are at Clinton Falls, Sherman & Winship, owners. They have 10 feet head of water, and three run of stone. It is a custom and flouring mill.

Medford Mills are at Medford, White, Beynon & Co., owners. They have 10 feet of head of water and 4 run of stone. They do only a flouring business.

There is said to be an available water-power, unimproved, at Lindensmith's between Owatonna and Clinton Falls.

Timber.

The time spent in this county was not long enough to make out a list of the woody plants at all approaching completeness. The following were noted:

Basswood. (*Tilia Americana. L.*)
Smooth Sumach. (*Rhus glabra. L.*)
Wild Grape. (*Vitis.*)
Virginia Creeper. (*Ampelopsis quinquefolia. Michx.*)
New Jersey Tea. (*Ceanothus Americanus. L.*)
Sugar Maple. (*Acer saccharinum. Wang.*)
Silvery Maple. (*A. dasycarpum. Ehr.*)
Red or Swamp Maple. (*Acer rubrum. L.*)
Box-elder. (*Negrundo aceroides. Mœnch.*)
False Indigo. (*Amorpha fruticosa. L.*)
Locust. (*Robinia Pseudacacia. L.*) Cultivated.
Wild Yellow or Red Plum. (*Prunus Americana. Marshall.*)
Cherry. (*Prunus.*)
Red Raspberry. (*Rubus strigosus. Michx.*)
Blackberry. (*R. villosus. Ait.*)
Crab. (*Pyrus arbutifolia. L.*)
Dogwood. *Cornus paniculata. L'Her.*)
Wolfberry. (*Symphoricarpus occidentalis. R. Br.*)
Ash. (*Fraxinus.*)
Slippery Elm. (*Ulmus fulva. Michx.*)
White Elm. (*U. Americana. L. pl. Clayt.*)
Butternut. (*Juglans cinerea. L.*)
Walnut. (*Juglans nigra. L.*)
Hickory. (*Carya.*)
Bur Oak. (*Quercus macrocarpa. Michx.*)
Black Oak. (*Quercus coccinea, Wang. var tinctoria, Bartram.*)
Wild Hazel-nut. (*Corylus Americana. Walt.*)
Iron-wood. (*Ostrya Virginica. Willd.*)
America Aspen. (*Populus tremuloides. Michx.*)
Cottonwood. (*P. monilifera. Ait.*)
Largetoothed Aspen. (*P. grandidentata. Michx.*)
Balm of Gilead. (*P. balsamifera. L. Var. candicans. Ait.*) Cultivated.

Geology.

The heaviness of the drift over this county effectually covers all the rock. The slight fall of the river enables it to uncover but little thus covered up. The only exposure of rock in the county is at Lindensmith's, about two miles below, and this exposure is but a slight one.

The rock is *Trenton Limestone*, and is first met at John Abbott's quarry, in section 33, of Clinton Falls. It is in the bed and on the low banks of the Straight River. The exposure at the time visited extended only about 4 feet above the surface of the water. The rock is in horizontal layers, 2–6 inches thick. It is blue on fresh fracture, yellow when weathered, compact, sparry, and contains many minute fragments of blue shale, like the corresponding rock at Minneapolis.

Just below, on section 28, is Lindensmith's quarry. The rock is in thicker layers than in Abbot's quarry. The following section was seen in one place, beginning above:

2 feet loam.
2 feet blue clay and limestone in thin layers.
4 feet—to water's surface—compact blue limestone, in thin layers.

The rock is like that in Abbott's quarry. Near by was another section as follows:

2½ ft. black and red loam.
2 ft. hard yellow clay.
7 ft. blue stone in layers 2-5 inches thick, extending to surface of water.

Below this there is no more rock until the county line is passed. At Wolcott Mills, about 1½ miles in Rice county, blue Trenton limestone has been quarried in the bed of the river.

No fossils were found in the rock. This stone is used for flagging and other purposes at Owatonna, and is considered a good stone.

Some evidence of the existence of a *Cretaceous* area in the State was found. On the southeast quarter of section 26, of Deerfield, on the farm of Aug. Hoffmann, coal has been found in sinking a well. Dr. G. A. Rossbach tells the writer that they went through 25 feet of black-blue clay, in the under part of which were fragments of coal. After that they passed through gravel in which also were coal fragments. At the depth of 63 or 64 feet rock was struck, the drill showed it to be black slate with pieces of coal imbedded in it. Although no specimens of the coal were seen by the writer the description given would answer for Cretaceous lignite. When the matter is further explored by capitalists which will, in probability, soon happen, all doubt as to the geological horizon of the rock will be cleared up. Meantime the evidence from the geology of adjoining counties, as well as the nature of the rock itself, justifies us in calling the rock Cretaceous. Just west of Owatonna another farmer is said to have struck coal also, though the writer was unable to get any further information on the matter.

The *Drift* is here, as already mentioned, very heavy. Sections of it were seen at several places. A gravel-knoll cut through at Owatonna showed one foot of black loam on the top, then four feet of yellow, sandy clay, then seven feet of assorted sand and gravel. Other sections along the railroads showed essentially the same arrangement. Among the gravel-pebbles, fragments of argillite were common.

The Owatonna mineral springs should be mentioned. They are nine in number, and are located about one and one-half miles northeast of the city. They lie along Maple Creek, at the base of a low clayey bluff. Of the five seen by the writer, four deposited iron. The water of the fifth had a decidedly bluish tint. Fountain spring was put down 22 feet and now flows out freely, raising the water about five feet above the surface. The others are natural springs. They are all undoubtedly due to the clay-floor underlying the loose materials of the drift. The taste of the water in the five visited by me was slightly mineral. The analysis of the water, published by the Owatonna Mineral Springs Company is appended. To which of the springs this analysis belonged could not be ascertained:

In one gallon, or 231 cubic inches, there are:

Chloride of Sodium	.1680 grains.
Sulphate of Sodium	.2856 "
Bicarbonate of Sodium	1.8592 "
Bicarbonate of Calcium	13.1992 "
Bicarbonate of Magnesium	5.2920 "
Bicarbonate of Protoxide of Iron	.6160 "
Alumina	.2800 "
Silica	1.1200 "
Organic Matter	a trace.
Total	22.8200 grains.

Cornell Brothers, at Owatonna, manufacture stoneware. The clay employed is a fine, rich, plastic, blue clay, and is at present obtained from Eldora, Hardin county, Iowa. This bed of clay is being exhausted, and its quality is deteriorating. This has determined the firm to try a gray clay found about one mile east of Owatonna. This is the same layer of clay which crops out at the mineral springs near the city. It has been found to work well. Excellent fire-brick is made from this clay. This firm has just started in business. They make about 1,000 gallons a week in jars, jugs, &c.

Dr. E. N. Morehouse makes brick from a bluish, yellow, washed clay, near Owatonna. He puts in the clay about one-third sand. He makes 225,000 bricks a year, for which he charges $8.00 to $12.00 per thousand, according to quality. He uses 50 cords of wood for every 100,000 of bricks. The wood costs $3.00 per cord at the place of cutting. The bricks are, like all of those made from

the washed clay, not first-class. Dr. Morehouse has experimented on making unglazed red ware from his clay, with fair results.

Odell and Cornell also make bricks near Owatonna. Bricks are also made on the farm of Mr. Skinner, near Blooming Prairie.

An artesian well has been subscribed for at Owatonna, and will probably soon be sunk. It must obtain results of great value for the Geological Survey.

TOPOGRAPHY.

The lists of railroad elevations given in the first annual report carried a net work of levels over the most of the inhabited portion of the State. They demonstrate the nearly level condition of the general surface of the State. The changes of level are, in that portion through which railroad lines have been run, of the nature of broad swells in the substructure, and indicate the changes in the geological formations, that bring on a series of hard and very enduring rocks, or a thickness of more erosible layers. Thus the Upper Devonian, in the southern tier of counties, is characterized by a considerable elevation above the formations that underlie it. The level surface that characterzes the Cretaceous in Steele and Dodge counties, as well as in much of the western part of the State, is attributable to the effect of that formation in toning down, and concealing, the irregularities in the old Devonian and Silurian surfaces. Thus there subsists a very intimate relation between the topography and the geology in the various parts of the State. The illustrations that have already been given in the report on the geology of Fillmore county, are still more striking proofs that the topography of a country is that which gives the first response to the enquiring geologist when locating the geological boundaries. For this reason it is highly desirable that all lines of railroad survey, which have been run in the State, should be made tributary to this end. It matters but little whether the railroads for which such surveys were intended were ever constructed. All that is needed is the comparative hights of the points along a known line. The undulations of the surface are very significant to the geologist.

The following lists are given as a further contribution to this subject. They have been furnished by the engineers of the Chicago, Milwaukee and St. Paul Railroad, and refer the points named to the level of the ocean. They pass through some of the principal cities and the wealthiest counties of the State.

RAILROAD ELEVATIONS.

THE CHICAGO, MILWAUKEE AND ST. PAUL R. R.

From the Records, by Robert Angst.

IOWA AND MINNESOTA DIVISION.

[*Note.*—The track is designated in all cases, when not otherwise mentioned.]

	Above the Ocean.
	Feet.
State Line, Lyle	1,099.46
Rose Creek, (Grade)	1,085.41
Rose Creek, (Bottom)	1,063.03
Dobin's Creek, (Grade)	1,094.76
Dobin's Creek, (Bottom)	1,071.46
Y at Austin Junction	1,094 45
Austin, (Station)	1,097.06
Wolf Creek, (Grade)	1,103.06
Wolf Creek, (Bottom)	1,076.06
Cedar River, (Grade)	1,100.00
Cedar River, (Bottom)	1,080.06
Ramsay, (Crossing S. M. R. R.)	1,114.86
Indian Creek, (Grade)	1,110.06
Indian Creek, (Bottom)	1,096.56
Lansing	1,124.06
Ingham's Creek, (Grade)	1,120.86
Ingham's Creek, (Bottom)	1,107.56
Top of swell, NE. ¼ Sec. 33, Udolpho, (Cut 3½ feet)	1,143.56
Swell, half a mile south of Madison, (Cut 1½ feet)	1,149.56
Madison	1,150.06
Top of divide 7½ miles N. of Madison, (Natural Surface)	1,149.50
Top of divide 7½ miles N. of Madison, (Grade)	1,146.00
Blooming Prairie, (Depot)	1,185.76
One-half mile S. E. of Aurora, (Bottom of marsh)	1,106.56
One-half mile S. E. of Aurora, (Grade)	1,114,56
Aurora Station. Sec. 17, Aurora Township	1,150.66
Havana. S. W. ¼ sec. 31	1,118,62
Top of divide between Havana and Owatonna. Sec. 24, (Grade and natural surface)	1,141.06
Winona and St. Peter Crossing. Owatonna	1,041.56
Owatonna, (Depot)	1,041.56

	Above the Ocean.
	Feet.
Maple Creek, (Grade)	1,028.46
Maple Creek, (Bottom)	1,012.06
Clinton Divide. Section 21, ¼ mile South of road-crossing, (cut 2 feet)	1,007.56
Medford	997.08
Straight River, (Grade)	986.40
Straight River, (Bottom)	958.06
Divide in Wolcott. S. W. ¼ sec. 19, (Natural surface)	1,051.06
Divide in Wolcott. S. W. ¼ sec. 19, (Grade)	1,034.06
Faribault	993.06
Cannon River, (Grade)	966.71
Cannon River, (Bottom)	948.56
Divide in Cannon City Township. N. E. ¼ sec. 24, (Natural surface)	1,039.06
Divide in Cannon City Township. N. E. ¼ sec. 24, (Grade)	1,007.06
Bottom of swamp, five miles N. of Faribault	961.56
Five miles N. of Faribault, (Grade)	993.06
Divide, S. W. ¼ sec. 31. Bidgewater, (Natural surface)	1,036.56
Divide, S. W. ¼ sec. 31. Bridgewater, (Grade)	1,027.56
Wolf Creek, (Grade)	964.56
Wolf Creek, (Bottom)	936.06
Dundas. Depot	945.71
Spring Creek, 1¾ miles S. W. of Northfield, (Grade)	907.06
Spring Creek, 1¾ miles S. W. of Northfield, (Bottom)	894.00
Heath Creek, (Grade),	912.06
Heath Creek, (Bottom)	894.56
Northfield. Depot	905.71
S. end of Plateau, 2 ms. N. of Northfield, (Nat. sur.) (Sec. 19, Waterford.)	972.06
S. end of Plateau, 2 ms. N. of Northfield, (Grade) (Sec. 19, Waterford.)	960.06
N. end of Plateau, 3 ms. N. of Northfield, (Nat. sur.) (Sec. 19, Waterford.)	969.06
N. end of Plateau, 3 ms. N, of Northfield, (Grade) (Sec. 19, Waterford.)	959.06
Foot of slope, near Chub Creek, (Grade and nat. sur.)	918.06
Foot of slope, 5 miles from Northfield, (Natural Surface)	910.06
Foot of slope, 5 miles from Northfield, (Grade)	913.06
Castle Rock Depot	925.76
Divide, sec. 18, Castle Rock Tp., (Natural Surface)	1,004.46
Divide, sec. 18, Castle Rock Tp., (Grade)	993.56
Divide, one mile south of Farmington, (Natural Surface)	904.31
Divide, one mile south of Farmington, (Grade)	893.31
Farmington	894.09
Farmington, Crossing H. & D. R. R	891.31
Vermillion River Crossing, (Bottom)	879.06
Vermillion River Crossing, (Grade.) Rolling surface to—	888.06
Rosemont Depot. Rolling surface to—	950.06
Westcott Station	873.06
St. Paul Junction, (at Mendota)	749.90
Crossing of the St. Paul & Sioux City R. R., Mendota	728.40
Mendota Junction	712.40
Crossing of the Minesota River. Fort Snelling	708.48
Crossing of the Minnesota River, (Bottom)	662.60
Fort Snelling Station	712.50
Minnehaha Station	802.80
Minnehaha Creek (grade)	806.20
Minnehaha Creek (bottom)	792.10
Minneapolis Depot	816.00

McGregor Division.

	Above the Ocean.
	Feet.
State Line, near Le Roy, Mower county (Nat. Sur. and Grade)..	1,163.47
Le Loy Depot	1,180.57
Divide, section 28, Le Roy, (Natural Surface)	1,205.47
Creek 2¼ miles west of Le Roy (Grade)	1,185.67
Creek, 2¼ miles west of Le Roy (Bottom)	1,167.97
Creek, 2¾ miles west of Le Roy (Grade)	1,185.67
Creek, 2¾ miles west of Le Roy (Bottom)	1,170.47
Taopi, (formerly Bellevue) section 16, Lodi (Grade)	1,236.47
Divide, ⅞ mile west of Taopi section 17 (Natural Surface)	1,245.47
Divide, ⅞ mile west of Taopi section 17 (Grade)	1,243.47
Adams, (Grade)	1,176.47
Creek, ¼ mile west of Adams, (Grade)	1,174.47
Creek, ¼ mile west of Adams, (Bottom)	1,159.47
Little Cedar river crossing (Grade)	1,172.47
Little Cedar river crossing (Bottom)	1,152.47
Divide, ¾ mile west of the Little Cedar (Natural Surface)	1,208.47
Divide, ¾ mile west of the Little Cedar (Grade)	1,201.17
Rose Creek Station	1,144.97
Rose Creek Crossing, (Grade)	1,136.47
Rose Creek Crossing, (Bottom)	1,122.47

River Division.

Low water at St. Paul	672.34
Grade of the L. S. & M. R. R., St. Paul, (near the old warehouse on the trestle work)	692.84
Dayton's Bluff, St. Paul, (Grade of R. R.)	696.34
Newport Station	737.87
Langdon	799.84
Hastings Depot, (Junction H. & D. R. R.)	696.31
Etter	677.84
Red Wing	673.84
Frontenac	707.34
Lake City	691.84
Reed's Landing	669.34
Wabasha	699.24
Kellogg	689.09
Weaver	660.84
Minneiska	659.44
Minnesota City	664.44
Crossing of the Winona & St. Peter R. R. (St. Peter Junction).	662.92
Winona	649.44
Homer	650.54
La Moille	647.44
Richmond	660.94
Dakota	644.44
Dresbach	663.44
La Crescent lime kiln, N. side of Houston county (Grade)	637.44

Hastings and Dakota R. R.

	Above the Ocean.
	Feet.
Hastings. Junction with the River Division Mil. & St. P. R. R.	696.31
Edge of prairie 3 miles W. of Hastings, Sec. 5, Marshan, (Grade and Nat. Surf.)	814.31
Thence slightly rolling surface, or nearly level, to—	
Nine and a half miles W. of Hastings, (Grade)	814.31
Nine and a half miles W. of Hastings, (Nat. Sur.)	822.31
Auburn	848.81
Sec. 27, Empire. Change of grade, (Nat. Sur.)	877.31
Sec. 27, Empire. Change of grade, (Grade)	876.31
Farmington, Crossing of the I. and M. Division	891.31
Fairfield, (Lakeville)	930.31
26¼ miles from Hastings, (Nat. Surface)	1,079.31
26½ miles from Hastings, (Grade)	1,069.81
⅛ mile E. of Prior Lake Station, (Natural Surface)	960.31
⅛ mile E. of Prior Lake Station, (Grade)	948.31
Prior Lake Station	936.31
Prior Lake, (Surface of water)	896.31
Prior Lake Crossing, (Bottom)	871.31
Cut ½ mile W. of Prior Lake Crossing, (Nat. Surface)	952.81
Cut ½ mile W. of Prior Lake Crossing, (Grade)	926.31
Cut 3 miles W. of Prior Lake Station, (Nat. Surface)	915.31
Cut 3 miles W. of Prior Lake Station, (Grade)	890.31
8 miles W. of Prior Lake Station, (Nat. Surface)	749.81
8 miles W. of Prior Lake Station, (Grade)	750.81
Shakopee, Crossing of the Sioux City R. R	742.81
Shakopee, Crossing of the Minnesota River, (Bottom)	657.31
Shakopee, Crossing of the Minnesota River, (Low water)	679.31
Shakopee, Crossing of the Minnesota River, (High water) [Extreme range of water, 27.1 feet.]	706.41
Shakopee, Crossing of the Minnesota River, (Grade)	714.31
Chaska depot	715.21
Chaska, Crossing of the Minneapolis and St. Louis R. R	716 81
Carver depot	802.11
Carver, Crossing of highway ¼ m. W. of depot, (Ravine, Bottom of)	736.31
Carver, Crossing of highway ¼ m. W. of Depot, (Grade)	805.00
Dahlgren, (Grade)	968.81
Dahlgren Station, (Nat. Surface)	975.81
Divide ½ m. W. of Dahlgren Station, (Nat. Surface)	976.31
Divide ½ m. W. of Dahlgren, (Grade)	970.31
Carver Creek crossing, (Bottom)	895.31
Carver Creek crossing, (Grade)	917.31
Benton Station, Divide, (Natural Surface)	943.31
Benton Station, Divide, (Grade)	934.31
Divide ¾ m. W. of Bonngard's Crossing, (Nat. Surface)	987.31
Divide ¾ m. W. of Bonngard's Crossing, (Grade)	978.31
Young America	977.31
Tiger Lake, Sec. 16, (Surface of water)	966.31
Divide 3½ miles W. of Young America; ½ m. E. of County Line, (Nat. Surface)	997.31
Divide 3½ ms. W. of Young America; ½ m. E. of Co. Line, (Grade)	991.31
Buffalo Creek Crossing, (Bottom)	953.31
Buffalo Creek Crossing, (Grade)	970.00
Divide ½ mile E. of Glencoe, (Nat. Surface)	1,013.31
Divide ½ mile E. of Glencoe, (Grade)	1,008.31
Glencoe Depot	990.01

Hasting and Dakota R. R. west of Glencoe, as surveyed in 1871 by F. A. Kimball, commencing on the range line between 30 and 31, at Round Grove, eighteen miles west of Glencoe.* From J. T. Dodge.

	Above the Ocean.
	Feet.
Glencoe Depot. Station 2,464.50	990.01
Nearly level to	
Station, 3,407	1,036.31
" 3,460	1,046.31
" 3,500	1,056.03
" 3,510	1,046.03
" 3,560	1,061.03
" 3,570	1,064.00
" 3,585	1,052.00
" 3,600	1,066.00
" 3,625	1,059.00
" 3,645	1,068.00
" 3,655	1,055.00
" 3,680	1,066.00
" 3,693	1,056.00
" 3,710	1,069.00
" 3,725	1,053.00
" 3,780	1,058.00
" 3,840	1,060.00
" 3,866	1,088.00
" 3,880	1,071.00
" 4,000	1,071.00
" 4,100	1,082.00
" 4,140	1,067.00
(Undulations 5–10 feet.)	
" 4,300	1,072.00
" 4,390	1,083.00
" 4,400	1,072.00
" 4,500	1,086.00
" 4,600	1,089.00
" 4,610	1,079.00
" 4,663	1,094.00
" 4,706	1,070.00
" 4,720	1,082.00
" 4,740	1,068.00
" 4,762	1,074.00
" 4,774	1,060.00
" 4,780	1,074.00
" 4,802 (E. Fork of Beaver Creek)	1,036.00
" 4,820	1,060.00
" 4,860	1,071.00
" 4,870	1,060.00
" 4,940	1,051.00
" 4,980 (W. Fork of Beaver Creek)	1,021.00
" 4,992	1,049.00
" 5,030	1,047.00
" 5,100	1,045.00
" 5,140 In N. E. ¼ Sec. 26, 115–36	1,047.00
" 5,160	1,041.00
" 5,165	1,056.00
" 5,170	1,045.00
" 5,190	1,046.00

* From Round Grove to Beaver Creek the survey was nearly in a due west course. From Hawk Creek to Big Stone Lake it ran from four to six miles north of the Minnesota River.

	Above the Ocean.
	Feet.
Station, 5,230	1,057.00
" 5,260	1,072.00
" 5,300	1,056.00
(Undulations of 15 feet.)	
" 5,300	1,043.00
" 5,420 (Sec. 13-18, R. 37-36.)	1,042.00
(Undulations.)	
" 5,460	1,022.00
" 5,490	1,046.00
" 5,570	1,056.00
" 5,610	1,041.00
(Undulations between 1,036 and 1,051.)	
" 5,740	1,031.00
" 5,750	1,026.00
" 5,760	1,038.00
" 5,790	1,048.00
" 5,810	1,031.00
" 5,830	1,039.00
" 5,900	1,026.00
" 5,930	1,038.00
" 5,947	1,023.00
" 5,976	1,036.00
" 6,020	988.00
" 6,023 (Hawk Creek)	970.00
" 6,030	999.00
" 6,040	1,007.00
" 6,090	1,009.00
" 6,094	1,010.00
" 6,096 (Creek)	989.00
" 6,100	1,008.00
" 6,140	1,012.00
" 6,142	996.00
" 6,145	1,012.00
" 6,230	1,031.00
" 6,315	1,010.00
" 6,340	1,018.00
" 6,400	1,004.00
" 6,417	988.00
" 6,460	1,021.00
(Undulating 5-10 feet.)	
" 6,600	1,014.00
" 6,625	985.00
" 6,660	997.00
" 6,672	988.00
" 6,730	1,008.00
" 6,770	987.00
" 6,820	1,000.00
" 6,824	1,001.00
" 6,826	980.00
" 6,828	996.00
" 6,850	980.00
" 6,870	970.00
" 6,880	983.00
" 6,910	978.00
" 6,930	941.00
" 6,960	959.00
" 6,968 (R. 40-41, Sec. 31-36.)	959.00
" 6,990	934.00

		Above the Ocean.
		Feet.
Station,	7,070	931.00
"	7,090	925.00
"	7,149	928.00
"	7,150 (Chippewa River)	913.00
"	7,154	931.00
"	7,260	918.00
"	7,320	934.00
"	7,350	915.00
"	7,370	913.00
"	7,390	933.00
"	7,403	925.00
"	7,405	940.00
"	7,415	932.00
"	7,426	950.00
"	7,432	941.00
"	7,490	968.00
"	7,590	974.00
"	7,603	991.00
"	7,630	986.00
"	7,645	969.00
"	7,690	977.00
"	7,790	980.00
"	7,860	997.00
"	7,910	981.00
"	8,030	986.00
"	8,039 (Pomme de Terre River)	960 00
"	8,050	985.00
"	8,120	994.00
"	8,240	1,000.00
"	8,310	986.00
"	8,370	996.00
"	8,390	1,017.00
"	8,420	1,018.00
"	8,480	987.00
"	8,500	985.00
"	8,560	991.00
"	8,580	986.00
"	8,640	1,002.00
"	8,700	1,012.00
"	8,800	1,017.00
"	8,850	1,038.00
"	8,880	1,012.00
"	8,930	1,015.00
"	8,970	1,018.00
"	8,994–5	973.00
"	8,998–9,000	990.00
"	9,003, (Creek)	965.00
"	9,008	1,011.00
"	9,030	1,017.00
"	9,060, (Sec. 13, 121.46)	1,006.00
"	9,100	1,041.00
"	9,110	1,044.00
"	9,140	1,068.00
	(Undulations, 10–15 feet.)	
"	9,170	1,072.00
"	9,190	1,079.00
"	9,200, (Opposite foot of Big Stone Lake, 1½ ms. SE. of it)	1,077.00
	Big Stone Lake, opposite Sta. 9,316	938.50

REPORT ON THE GENERAL MUSEUM.

CONTAINING THE COLLECTIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY FOR 1875.

BY N. H. WINCHELL, CURATOR.

The Museum of the State University, at Minneapolis, is designed to exemplify to the people of the State the natural resources of the State of Minnesota, so far as the same are covered by the investigations ordered by the law creating a geological and natural history survey. It is also designed to afford to the students who may avail themselves of the instruction offered by the University, the means of illustration needed in the study of the Natural Sciences. In addition to the collections directly made by the survey, the law orders a system of exchanging with other institutions with a view of so augmenting the number of specimens on exhibition as to comprise finally a tolerably complete series of the different species and objects of interest and curiosity that are afforded by the Natural Sciences.

Prior to the commencement of the Geological and Natural History survey, there was a nucleus of a museum already in existence in the University. This comprised a variety of objects, many from the State of Minnesota, and others from foreign localities. The collections that have accumulated since the survey began have been withheld necessarily from exhibition owing to the lack of suitable room with proper cases and furniture for their exhibition and preservation. During the past year, however, the new University building having been substantially completed, room has been set aside for the museum, and a set of cases are rapidly approaching

completion, suitable for the reception of some, if not all, of the collections that belong to the museum.

The mammals that were collected in the Black Hills, mentioned in the last statement on the condition of the museum, have been mounted by Prof. H. A. Ward, of Rochester, New York, and are only awaiting the arrangement of the room to be set up in the University. They comprise antelope, male and female, deer with young, elk, elk head, badger, grizzly bear with young, and weasel. The moose which was secured last winter has also been mounted by Prof. Ward, and for the same reason is not on exhibition. It is kindly kept in store by Prof. Ward till our rooms are ready. This fine specimen was killed in December, 1874, by Peter Young, ("Wild Pete,") in the east part of Otter Tail county, on the north end of Parker's Prairie, after having been pursued about five miles. He was seen about a mile away, coming toward the hunter, on a trot, and passed within six rods of him. The first shot put a ball through his throat, but it required four or five more to bring him down. He was billed as freight to St. Paul, after the entrails were removed, with a weight of 590 pounds. His flesh and bones, without the neck and lower leg-bones, weighed 465 pounds. The specimen, as mounted, is pronounced one of rare size and perfection. In procuring and caring for this moose, before he was sent to Prof. Ward, Messrs. Wm. A. Van Slyke and Merrill Ryder, both of St. Paul, rendered much assistance.

In August the generosity of a few citizens of Minneapolis aided the Board of Regents to make the purchase of a fine set of Prof. Ward's casts. These are in plaster of paris, and are of life size, and will give the rooms assigned to the Museum a very attractive appearance. The contributors to this fund were the following gentlemen:

Judge E. S. Jones	$50 00
Gov. J. S. Pillsbury	150 00
Hon. L. Butler	150 00
Dr. H. H. Kimball	10 00
R. J. Mendenhall	10 00
Hon. E. M. Wilson	10 00
Hon. R. B. Langdon	50 00
Hon. H. T. Welles	50 00
S. C. Gale, Esq	25 00
Chute Brothers	10 00
Judge Isaac Atwater	15 00
D. S. Story	5 00
Jonathan Chase	100 00

Anthony Kelly	5 00
Wyman Elliott	5 00
Thomas Lowry	25 00
Hon. A. M. Reid	25 00
Hon. Paris Gibson	25 00

The full cost of the set was $1,500. It embraces the following specimens:

LIST OF WARD'S CASTS OF FOSSILS IN THE UNIVERSITY MUSEUM.

VERTEBRATA.

MAMMALIA.

[NOTE.—The numbers prefixed are those of Prof. Ward's Catalogue.]

2. Homo.....Engis Cavern, Belgium.
Pleistocene.

4. Homo.....Guadaloupe.
Modern Concretionary Limestone.

4. (C.L.) Mesopithecus Pentelici. *Wagner*.....Pikermi, Greece
Upper Miocene.

7. (C. L.) Machairodus cultridens. *Cuv*.....Pikermi, Greece.
Upper Miocene.

11. Hyæna eximia. *Wagner*.....Pikermi, Greece.
Pleistocene.

15. Amphicyon major. *Lartet*.....Sansans, S. France.
Miocene Tertiary.

16. Ursus spelæus. *Blum*, (skull.).....Cave of Gailerneuth, Bavaria.
Quaternary.

17. Ursus spelæus. *Blum*, (pair of molars). Cave of Gailenreuth, Bavaria.
Quaternary.

18. Ursus spelæus. *Blum*. (canine tooth.). Cave of Gailenreuth, Bavaria.
Quaternary.

19. Gulo spelæus. *Goldf*.....Cave of Gailenreuth, Bavaria.
Quarternary.

20. Trogontherium Cuvieri. *Fisch*.....Ostend, England.
Pliocene Tertiary.

21. Castoroides Ohioensis. *Foster*.....Clyde, N. Y.
Pleistocene.

23. Megatherium Cuvieri. *Desm*.....Buenos Ayres, S. A.
Pampean Formation.

26. Megatherium Cuvieri. *Desm.* (tooth.).. .....Buenos Ayres, S. A.
Pleistocene.

34. Megalonyx Jeffersonii. *Harlan*.....Henderson, Ky.
Pleistocene.

35. Megalonyx Jeffersonii. *Harlan*.....Cave, West Virginia.
Pleistocene.

36. Glyptodon typus. *Nodat*.....Pampean Deposit, Buenos Ayres.
Pleistocene.

41. Glyptodon reticulatus. *Owen.* (caudal armor.).....Buenos Ayres.
Pleistocene.

43. Glyptodon clavipes. *Owen.* (reduced.).....Buenos Ayres.
Pleistocene.

54. Bootherium cavifrons. *Leidy*.....Ft. Gibson, Indian Territory.
Pleistocene.

55. Bootherum bombifrons. *Leidy*.....Big-bone Lick, Ky.
Pleistocene.

57. Oreodon Culbertsonii. *Leidy*.....Mauvaises Terres, Neb.
Miocene Tertiary.

59. Anoplotherium commune. *Cuv*.....Montmatre, Paris.
Eocene Gypsum.

60. Anoplotherium commune. *Cuv.* (right forefoot)..Montmatre, Paris.
Eocene Tertiary.

61. Anoplotherium commune. *Cuv.* (left hindfoot)...Montmatre, Paris.
Eocene Tertiary.

69. Chœropotamus Parisiensis. *Aym.* (skull).....Montmatre, Paris.
Eocene Tertiary.

71. Anthracotherium magnum. *Cuv*.....Auvergne, France.
Miocene Tertiary.

72. Lophiochaerus splendens.....St. Albans, France.
Miocene Tertiary.

73. Hippohyus Sivalensis. *Falc. and Caut*.....Sewalik Hills, India.
Miocene Tertiary.

78. Hippopotamus major. *Cuv.* (right tusk.)

79. Hippopotamus major. *Cuv.* (left hindfoot).....Auvergne, France.
Pliocene Tertiary.

80. Equus namadicus. *Falc. and Caut*.....Sewalik Hills, India.
Miocene Tertiary.

83. Hipparion elegans. *Christol*.....Concurron, France.
Lower Pliocene.

87. Anchitherium Aurelianense. *Gerv*.....St. Alban, France.
Upper Miocene.

89. Rhinoceros platyrhinus. *Falc. and Caut.*.....Sewalik Hills, Ind.
Miocene.

90. Rhinoceros palæindicus. *Falc. and Caut.*.....Sewalik Hills, India.
Miocene Tertiary.

95. Rhinoceros pleuroceros, (lower jaw).....Gannat, France.
Miocene Tertiary.

99. Rhinoceros Merkii. *Kaup*.....Steinheim, Wirtemberg.
Miocene Tertiary.

100. Rhinoceros incisivus. *Cuv.*, (upper incisor).....Steinheim, Ger.
Miocene Tertiary.

102. Tapirus Avernensis. *Croiz and Job*.....Auvergne, Central France.
Pliocene Tertiary.

103. Tapirus Avernensis. *Croiz. and Job*..... Auvergne, France.
Plocine.

104. Lophiodon Parisiense. *Gerv*.....Paris, France.
Eocene Tertiary.

105. Pliolophus vulpiceps. *Owen*.....England.
London Clay (Eocene.)

106. Palæotherium crassum. *Cuv*.....Montmartre, Paris.
Eocene Gypsum.

109. Palæotherium crassum. *Cuv*.....Monturartre, Paris.
Eocene Gypsum.

111. Palæotherium crassum. *Cuv.*, (left hind foot).....Paris, France.
Eocene Tertiary.

113. Dinotherium giganteum. *Kaup*.....Eppelsheim, Rhine Valley.
Miocene Tertiary.

118. Dinotherium levius, (upper jaw, left ramus).....St. Albans, France.
Miocene Tertiary.

119. Dinotherium levius, (upper jaw).....St. Albans, France.
Miocene Tertiary.

124. Dinotherium giganteum. *Kaup*.....St. Jean le Vieux, France.
Miocene Tertiary.

132. Elephas primigenius. *Blum*.....Lippe, Prussia.
Pleistocene.

133. Elephas primigenius. *Blum*.....Dept. of Ain, France.
Pleistocene.

136. Elephas intermedius, (molar.).....River Saone, France.
Pleistocene.

137. Elephas intermedius, (molar.).....St. Germain, France.
Pleistocene.

138. Elephas meridionalis. *Nesti*.....Basses Alpes, France.
Pliocene Tertiary.

142. Elephas Americanus. *Dekay*.....Homer, Cortland Co., N. Y.
Pleistocene.

143. Elephas Americanus. *DeKay*.....St. Catharines, C. W.
Pleistocene.

155. Mastodon giganteus. *Cuv.* (molar).....Big Bone Lick, Ky.
Pleistocene.

159. Mastodon longirostris. *Kaup.* (molar).....Lyons, France.
Miocene Tertiary.

169. Mastodon longirostris. *Kaup.* (tusk of lower jaw)...Lyons, France.
Miocene Tertiary.

171. Mastodon giganteus. *Cuv*.....St. Catharines, C. W.
Pleistocene.

176. Zeuglodon cetoides. *Owen.* (two teeth).....Claiborne, Ala.
Eocene Tertiary.

178. Rhizoprion Schinzi, (head.).....Central France.
Miocene Tertiary.

179. Balaenodon gibbosus. *On.* (tympanic bones).....Suffolk, England.
Pliocene Tertiary.

181. Diprotodon Australis. *Owen*.....Darling Downs, Australia.
Pleistocene.

AVES.

184. Didus ineptus, (head).....Mauritius.
Alluvium.

186. Æpiornis maximus. *St. Hil.* (egg).....Madagascar.
Pleistocene.

186. Æpiornis maximus. *St. Hil.* (metatarsal).....Madagascar.
Pleistocene.

188. Palapteryx ingens. *On.* (right foot).....New Zealand.
Pleistocene.

189. Brontozooum gigantum. *Hitch.* (tracks).....Northampton, Mass.
Lias.

192. Brontozooum Sillimanium. *Hk.* (tracks).....Middletown, Conn.
Lias.

REPTILIA.

196. Polemarchus gigas. *Hk.* (track).....Chicopee Falls, Mass.
Lias.?

149. (C. L.) Iguanodon Mantelli. *Meyer*.....Isle of Wight.
Wealden.

211. Ichthyosaurus communis. *Conyb*.....Lyme-Regis, England. Lias.

212. Ichthyosaurus communis. *Conyb*. (head).....Barrow-on-Soar, Eng. Lias.

213. Ichthyosaurus communis. *Conyb*. (head).....Lyme-Regis, Eng. Lias.

214. Ichthyosaurus commnnis. *Conyb*. (paddle).....Boll, Wirtemberg. Lias.

219. Ichthyosaurus platyodon. *Conyb*.....Lyme-Regis, Eng. Lias.

220. Ichthyosaurus tenuirostris. *Conyb*.....Boll, Wirtemberg. Lias.

222. Ichthyosaurus tenuirostris. *Conyb*.....Boll, Wirtemberg. Lias.

225. Plesiosaurus dolichodeirus. *Conyb*.....Glastonbury, Eng. Lias.

227. Plesiosaurus macrocephalus. *Conyb*.....Lyme-Regis, Eng. Lias.

231. Pliosaurus brachydeirus. *Owen*., (paddle).....Dorchester, Eng. Upper Oolite.

233. Pliosaurus grandis. *Owen*, (tooth).....Dorchester, Eng. Upper Oolite.

237. Placodus gigas. *Agass*.....Laineck, Bavaria. Muschelkalk (Trias.)

239. Placodus gigas. *Agass*.....Laineck, Bavaria. Muschelkalk (Trias.)

241. Pterodactylus crassirostris. *Goldf*.....Solenhofen, Bavaria. Upper Oolite.

242. Pterodactylus rhamphastinus. *Wagner*.....Solenhofen, Bavaria. Middle Oolite.

247. Crocodilus biporcatus. *Cuv*. (head).....Sewalik Hills, India. Miocene Tertiary.

249. Crocodileimus robustus.....Dept. of Ain, France. Upper Oolite.

251. Aligatorellus Beaumontii.....Dept. of Ain, France. Middle Oolite.

253. Teleosaurus Mandelslohi. *Bronn*.....Holzmaden, Wirtemberg. Lias.

255. Teleosaurus longipes. *Bronn*.....Boll, Wirtemberg. Lias.

256. Teleosaurus Cadomensis. *St. Hil*. (ventral scales)....Caen, France. Lower Oolite.

262. Mosasaurus Hoffmanni. *Mantell*.....Maestricht, Holland.
Upper Chalk.

268. Homœosaurus Maximiliani. *Meyer*.....Kelheim, Bavaria.
Middle Oolite.

270. Saphæosaurus laticeps. *Meyer*.....Kelheim, Bavaria.
Middle Oolite.

277. Sauranodon incisivus.....Dept. of Ain, France.
Middle Oolite.

278. Dicynodon lacerticeps. *Owen*.....Fort Beaufort, Cape Colony.
Trias.

281. Testudo hemispherica. *Leidy*.....Mauvaises Terres, Nebraska.
Miocene Tertiary.

285. Pleurosternon ovatum. *Owen*..... .....Swanage, England.
Upper Oolite.

286. Chelonemys ovata, (ventral surface.).....Cirin, France.
Middle Oolite.

287. Chelonemys plana, (ventral surface.).....Cirin, France.
Middle Oolite.

289. Hydropelta Meyeri. *D'Orb*.....Cirin, France.
Middle Oolite.

292. Labyrinthodon Jægeri. *Owen*.....Stuttgardt, Wirtemberg.
Keuper (Trias.)

297. Andrias Scheuchzeri, *Tschudi*.....Œningen, Switzerland.
Miocene Tertiary.

298. Andrias Tschudi. *Meyer*.....Rott, Rhine Valley.
Miocene Tertiary.

225. (C. L.) Cheirotherium Barthi. *Kaup*..... .....Jena, Germany.
Lower Trias (New Red Sandstone.)

299. Rana diluviana. *Goldf*.....Bonn, Rhine Valley.
Miocene Tertiary.

302. Pterodactyle (restored.).....Kent, England.
Chalk.

303 Megalosaurus, (restored.).....Oxfordshire, etc., England.
Oolite.

304. Iguanodon, (restored.).....Sussex and Kent, England.
Wealden.

305. Labyrinthodon, (restored.) .....Cheshire, England.
Trias.

306. Icthyosaurus, (restored.).....Somersetshire, etc., England.
Lias.

307. Plesiosaurus macrocephalus. *Conyb.* (restored.)...Dorsetshire, etc.,
Lias. England.

308. Plesiosaurus dolichodeirus. *Conyb.* (Restored.)...Somersetshire, etc., England.
Lias.

PISCES.

309. Holoptychius nobilissimus. *Agass*.....Clashbinnie, Scotland.
Old Red Sandstone.

313. Cephalaspis Lyelli. *Agass*.....Forfarshire, Scotland.
Old Red Sandstone.

315. Lepidotus maximus. *Wagn*.....Solenhofen, Bavaria.
Upper Oolite.

316. Lepidotus oblongus. *Agass*.....Solenhofen, Bavaria.
Middle Oolite.

317. Lepidotus minor. *Agass*.....Isle of Portland, England.
Upper Oolite.

320. Microdon (Pycnodus) elegans. *Agass*.....Kelheim, Bavaria.
Upper Oolite.

321. Microdon notabilis. *Munst*.....Kelheim, Bavaria.
Middle Oolite.

324. Gyrodus circularis. *Agass*.....Solenhofen, Bavaria.
Upper Oolite.

328. Megalurus lepidotus. *Agass*.....Solenhofen, Bavaria.
Lithographic Slate (Upper Oolite.)

330. Squatina acanthoderma. *Fraas*.....Eichsädt, Bav.
Upper Oolite.

331. Thaumas alifer. *Munst*.....Eicshtadt, Bavaria.
Middle Oolite.

333. Carcharodon.....Isle of Malta.
Miocene.

336. Acrodus nobilis. *Agass*.....Lyme-Regis, Eng.
Lias.

338. Plycodus decurrens. *Agass*.....Kent, Eng.
Chalk.

342. Mesturus verrucosus. *Wagner*.....Eichstadt, Bavaria,
Middle Oolite.

344. Ichthyodorulite, (dorsal spine).....Lyme-Regis, Eng.
Lias.

347. Holocentrum pygæum. *Agass*.....Monte Bolca, Italy.
Eocene Tertiary.

1201. Coprolite of Fish.....Kent, Eng.
Lower Chalk.

ARTICULATA.

CRUSTACEA.

353. Enoploclytea Sussexiensis. *Mant.* (claw).....Lewes, England.
Lower Chalk.

354. Eryon propinquus. *Germar*.....Eichstadt, Bavaria.
Upper Oolite.

358. Pemphyx Sueurii. *Meyer*.....Crailsheim, Wirtemberg.
Muschelkalk (Middle Trias.)

365. Limulus Walchii. *Desm*.....Eichstadt, Bavaria.
Middle Oolite.

367. Euripterus lacustris. *Harlan*.....Williamsville, N. Y.
Waterlime Group, (Upper Silurian.)

368. Eurypterus lacustris. *Harlan*.....Williamsville, N. Y.
Waterlime Group, (Upper Silurian.)

372. Pterygotus Anglicus. *Agass*.....Forfarshire, Scotland.
Old Red Sandstone.

373. Asaphus gigas. *Dalm.* (restored from fragments.)..Adams Co. Ohio.
Lower Silurian.

374. Asaphus gigas. *Dalm.*.....Cincinnati, Ohio.
Lower Silurian.

380. Asaphus expansus. *Dalm*.....Motala, Sweden.
Lower Silurian.

382. Asaphus tyrannus. *Murch*.....Bishop's Castle, Wales.
Llandeilo Flags. (L. Sil.)

384. Asaphus Barrandi. *Hall*.....Platteville, Wis.
Trenton limestone, (L. Silurian.)

388. Angelina Sedgwicki. *McCoy*.....Garth, Wales.
Lower Silurian.

390. Bumastus Barriensis. *Murch*.....New York.
Niagara Group.

393. Bronteus planus. *Barr*.....Beraun, Bohemia.
Upper Silurian.

394. Calymene Blumenbachii. *Brongniart*.....Dudley, England.
Upper Silurian.

395. Calymene Blumenbachii. *Brong*.....Dudley, England.
Upper Silurian.

396. Calymene senaria. *Conrad*.....Cincinnati, Ohio.
Lower Silurian.

397. Calymene læviceps. *Dalm*.....Motala, Sweden.
Lower Silurian.

398. Ceraurus pleurexanthemus. *Green.* (partially restored.)
Lower Silurian.

399. Ceraurus pleurexanthemus. *Green*.....Ottawa River.
Trenton limestone.

400. Chirurus claviger. *Beyr* .....Wesela, Boh.
Lower Silurian.

401. Conocephalus Sulzeri. *Schloth*.....Ginetz, Bohemia.
Lower Silurian.

402. Cychaspis Chrystyi. *Hall*.....Waldron, Ind
Niagara Group.

405. Dalmania calliteles. *Green*..... .....York, N. Y.
Hamilton Group.

408. Dalmania micrurus. *Green*.....Schoharie county, N. Y.
Lower Helderberg.

411. Dalmania nasutus. *Conrad*.....Schoharie county, N. Y.
Lower Helderberg.

414. Dalmania selenurus. *Eaton*.....Auburn, N. Y.
Upper Helderberg.

415. Dalmania socialis. *Barr*.....Bohemia.
Lower Silurian.

417. Dindymene Bohemica. *Barr*.....Rokycan, Bohemia.
Lower Silurian.

421. Harpes ungula. *Barr*.....Kronieprus, Bohemia.
Upper Silurian.

422. Harpides Grimmi. *Barr*.....Przibram, Bohemia.
Lower Silurian.

423. Homalonotus delphinocephalus. *Murch*.....Dudley, England.
Upper Silurian.

428. Lichas Boltoni. *Green*.....Lockport, N. Y.
Niagara Group.

429. Lichas grandis. *Hall.* (head.).....Schoharie county, N. Y.
Schoharie Grit, (Devonian.)

430. Lichas grandis. *Hall.* (pygidium reversed.)....Schoharie Co., N. Y.
Schoharie Grit, (Devonian.)

433. Ogygia Buchii. *Goldf*.....South Wales.
Lower Silurian.

436. Olenellus Thompsoni. *Hall*..... .....Georgia, Vt.
Quebec Group, (Lower Silurian.)

437. Paradoxides Bohemicus. *Bock*.....Ginetz Bohemia.
Lower Silurian.

439. Pradoxides Davidis. *Salter*.....St. Davids, Wales.
Lower Silurian.

442. Phacops cephalotes. *Corda*.....Tetin, Bohemia.
Upper Silurian.

INSECTA.

451. Æchna eximia. *Hagen*.....Solenhofen, Bav.
Lithographic Limestone, (Middle Oolite.)

ANNELIDA.

454. Vermetus gigas. *Biv*.....Asti, Piedmont.
Miocene Tertiary.

455. Tentaculites elongatus. *Hall*.....Schoharie Co. N. Y.
Lower Helderberg.

MOLLUSCA.

CEPHALOPODA.

456. Belemnites Oweni. *Pratt*, (guard).....Christian Malford, England.
Upper Oolite.

457. Belemnites Oweni. *Pratt*.....Christian Malford, England.
Upper Oolite.

458. Belemnites giganteus. *Schloth*.....Ehningen, Wirt.
Lias.

461. Belemnites acuarius. *Schloth*.....Whitby, England
Lias.

462. Belemnites lateralis. *Phil.* (guard.).....Yorkshire, Eng.
Cretaceous.

463. Beloteuthis subcostata. *Munst*.....Holzmaden, Wirt.
Lias.

467. Ammonites armatus. *Sow*.....Charmouth, Eng.
Lias.

468. Ammonites Aon. *Munst*.....St. Cassian, Austria.
Trias.

472. Ammonites Batesi. *Trask*.....Shasta Co., California.
Cretaceous.

473. Ammonites bisulcatus. *Brug*.....Rautenberg, Brunswick.
Lower Lias.

475. Ammonites Blagdeni. *Sow*.....Dorsetshire, England.
Lower Oolite.

476. Ammonites Birchii. *Sow*.....Charmouth, England.
Lias.

477. Ammonites Bechei. *Sow*.....Charmouth, England.
Lias.

478. Ammonites Brongniarti. *Sow*.....Yeovil, England.
Lower Oolite.

484. Ammonites cordatus. *Sow*.....Calvados, France.
Middle Oolite.

485. Ammonites cordatus. *Sow*.....Calvados, France
Middle Oolite.

487. Ammonites coronatus. *Brug*.....Villere, France.
Middle Oolite.

490. Ammonites fimbriatus. *Sow*.....Charmouth, England.
Middle Lias.

491. Ammonites fimbriatus. *Sow*.....Charmouth, Eng.
Middle Lias.

492. Ammonites gigas. *Zieten*.....Yonne, France.
Upper Oolite.

495. Ammonites Goliathus. *D'Orb*.....Dives, France
Middle Oolite.

497. Ammonites Henleyi. *Sow*.....Charmouth, England.
Lias.

498. Ammonites Herveyi. *Sow*.....Wilts, England.
Middle Oolite.

500. Ammonites heterophyllus. *Sow*.....Reutlingen, Wirtemberg.
Lias.

501. Ammonites Humphriesianus. *Sow*.....Yeovil, England.
Lower Oolite.

502. Ammonites ——.....Calvados, France.
Middle Oolite.

503. Ammonites interruptus. *Brug*.....St. Florentin, France.
Cretaceous.

504. Ammonites interruptus, *Park*.....France.
Gault (Cretaceous).

505. Ammonites Jason. *Rein*.....Christian Malford, Eng.
Middle Oolite.

509. Ammonites linguiferus. *D'Orb*.....Calvados, France.
Lower Oolite.

511. Ammonites macrocephalus. *Schloth*.....Wiltshire, England.
Middle Oolite.

515. Ammonites margaritatus. *Mum*.....Charmouth, Eng.
Lias.

518. Ammonites Millesianus. *D'Orb*.....Rouen, France.
Chalk.

519. Ammonites modiolaris. *Luid*.....Wiltshire, England.
Middle Oolite.

521. Ammonites obtusus. *Sow*.....Charmouth, England.
Lower Lias.

523. Ammonites peramplus. *Mant*.....Germany.
Chalk.

525. Ammonites planicostatus. *Sow*.....Dorset, England.
Lias.

527. Ammonites raricostatus. *Ziet*.....Charmouth, England.
Lias.

529. Ammonites Rhotomagensis. *Brong*.....Rouen, France.
Chalk.

531. Ammonites serpentinus. *Schloth*.....Boll, Wirtemberg.
Lias.

536. Ammonites Woollgari. *Mant*.....Sussex, England.
Chalk.

537. Ammonites Woollgari. *Mant*.....Sussex, England.
(Enlarged from 536.)

538. Ammonites gigas. *Ziet.* (Enlarged from 492.).....Yonne, France.
Upper Oolite.

539. Ancyloceras Andouli. *Astier*.....Cheiron, France.
Cretaceous Greensand.

540. Ancyloceras Emerici. *D'Orb*.....Barreme, France.
Upper Neocomian, (Cretaceous)

541. Ancyloceras gigas. *Sow*.....Atherfield, Isle of Wight.
Cretaceous Greensand.

543. Ancyloceras Tabarelli. *Astier*.....Barreme, France.
Cretaceous.

546. Baculites anceps. *Lam*.....France.
Chalk.

547. Ceratites nodosus. *DeHaan*.....Luneville, France.
Muschelkalk, (Trias.)

551. Crioceras bifurcatus. *Quenst*.....Reutlingen, Wirtemberg.
Jurassic.

552. Crioceras Duvalii. *Lev*.....Escragnolles, France.
Neocomian (Cretaceous.)

553. Goniatites expansus. *Vanux*.....Manlius, N. Y.
Goniatite limestone (Devonian.)

554. Goniatites ixion. *Hall*.....Rockford, Ind.
Carboniferous.

555. Hamites attenuatus. *Sow*.....Folkestone, England.
Gault (Cretaceous.)

557. Hamites Astierianus. *D'Orb*.....Barreme, France.
Neocomian (Cretaceous.)

558. Hamites (Hamulina) cinctus.) *D'Orb*.....Barreme, France.
Upper Neocomian (Cretaceous.)

563. Scaphites Ivanii. *Puzos*.....Barreme, France.
Lower Greensand.

564. Scaphites compressus. *Röm*.....Haldem, Westphalia.
Chalk.

566. Toxoceras obliquatum. *D'Orb*.....Escragnolles, France.
Greensand (Cretaceous.)

567. Turrilites costatus. *Lam*.....Rouen, France.
Chalk Marl (Lower Cretaceous.)

569. Nautilus bidorsatus. *Schloth*.....Brunswick, Germany.
Muschelkalk (Trias.)

573. Nautilus Neocomensis. *D'Orb*.....Escragnolles, France.
Neocomian (Cretaceous.)

574. Nautilus pseudo-elegans. *D'Orb*.....Rouen, France.
Chalk.

575. Nautilus semistriatus. *D'Orb*.....Charmouth, Eng.
Lias.

578. Nautilus ——.....Charmouth, Eng.
Middle Lias.

579. Nautilus ——.....Kentucky.
Carboniferous ?

580. Lituites undatus. *Conrad*.....Middleville, N. Y.
Black River limestone, (L. Sil.)

582. Discites ornatus. *Hall*.....Manlius, N. Y.
Goniatite limestone, (Devonian.)

585. Orthoceras amplicameratum. *Hall*.....Middleville, N. Y.
Trenton Limestone, (Lower Silurian.)

586. Orthoceras crebrum. *Sœm*.....Eifel, Rhine Valley.
Devonian.

587. Orthoceras inequale. *Barr*.....Butowitz, Bohemia.
Upper Silurian.

592. Gomphoceras inflatum. *Quenst*.....Eifel, Rhine Valley.
Devonian.

597. Phragmoceras subventricosum. *D'A and De V*..Eifel, Rhine Valley.
Devonian.

598. Cyrtoceras macrostomum. *Hall*.....Mineral Point, Wis.
Trenton Limestone (L. Sil.)

599. Cyrtoceras corbulatum. *Barr*.....Bohemia.
Upper Silurian.

600. Cyrtoceras elongatum. *Barr*.....Beraun, Bohemia.
Upper Silurian.

602. Gyroceras trivolvis. *Conrad*.....Schoharie county, N. Y.
Upper Helderberg, (Devonian.)

604. Gyroceras expansum. *Sæm*..... ...Cazenovia, N Y.
Hamilton Group.

605. Gyroceras Eifelense. *D'Arch*.....Eifel, Rhine Valley.
Devonian.

GASTEROPODA.

608. Rostellaria carinata. *Mant*..... .....Folkestone, England.
Gault. (Cretaceous.)

609. Pyrula melongena. *Grateloup*.....Saucats, France.
Miocene Tertiary.

611. Fusus longaevus. *Lam*.....Bracklesham, England.
Eocene Tertiary.

619. Cerithium giganteum. *Lam*.....Damery, France.
Eocene Tertiary.

620. Cerithium giganteum. *Lam*, (inner cast).....Vaugirard, France.
Eocene Tertiary.

621. Cerithium cornucopiæ. *Sow*.....Contentin, France.
Eocene Tertiary.

624. Euomphalus rugosus. *Sow*.....Dudley, England.
Upper Silurian.

633. Capulus elegans. *Barr*.....Bohemia.
Upper Silurian.

634. Capulus robustus. *Barr*..... .....Zochkow, Bohemia.
Upper Silurian.

637. Dentalium Noe. *Bon*.....Astezan, Piedmont.
Pliocene Tertiary.

LAMELLIBRANCHIATA.

647. Ostrea frons. *Park*.....Royan, France.
Chalk.

648. Ostrea Santonensis. *D'Orb*.....Royan, France.
Chalk.

650. Gryphæa arcuata. *Lam*.....Semur, France.
Lias.

651. Exogyra columba. *Goldf*.....Boussa, France.
Cretaceous.

652. Exogyra costata. *Morton*.....Perry Co., Alabama.
Cretaceous.

658. Radiolites crateriformis. *D'Orb*.....Royan, France.
Chalk.

660. Sphærulites Bournoni. *Desm*.....Dordonge, France.
Chalk.

661. Sphærulites calceoloides. *Desm*.....Dordogne, France.
Chalk.

663. Caprina adversa. *D'Orb*.....Charente, France.
Chalk.

664. Avicula flabella. *Conrad*.....Onondaga Co., N. Y.
Hamilton Group (Devonian.)

670. Pterinea radians. *Conrad*.....Casenovia, N. Y.
Hamilton Group (Devonian.)

671. Posidonia alveata. *Conrad*.....Sherburne, N. Y.
Hamilton Group (Devonian.)

672. Megambona cordiformis. *Hall*. .....Onondaga Co., N. Y.
Corniferous Limestone (Devonian.)

675. Hippopodium ponderosum. *Sow*.....Cheltenham, Eng.
Lias.

679. Trigonia costata. *Park*.....Œschingen, Wirt.
Lower Oolite.

683. Modiola plicata. *Sow*.....Rendcomb, Eng.
Oolite.

686. Thracia —— .....Thebes, Egypt.
Cretaceous.

689. Teredina personata. *Lam*.....Mt. Bernon, France.
Eocene Tertiary.

BRACHIOPODA.

690. Spirifer pinguis. *Sow*.....Dublin, Ireland.
Carboniferous limestone.

696. Spirifer oxypteris. *Burv*.....Carignan, France.
Lias.

706. Terebratula grandis. *Blum*.....Bunde, Westphalia.
Miocene Tertiary.

716. Terebratula intermedia *Sow*.....Calvados, France.
Lower Oolite.

755. Productus giganteus. *Martin*.....Derbyshire, England.
Carboniferous.

RADIATA.

ECHINODERMATA.

762. Cidaris coronata. *Goldf*.....Nattheim, Wirtemberg.
Coral Crag (Middle Oolite.)

776. Hemicidaris intermedia. *Flem*.....Wiltshire, England.
Oolite.

781. Palaechinus multipora. *Nor. and O*.....St. Louis, Mo.
St. Louis Limestone (Carboniferous.)

802. Echinobrissus clunicularis. *Blainv*.....Stroud, England.
Lower Oolite.

814. Clypaeaster umbrella. *Agass*.....Sardinia.
Miocene Tertiary.

821. Discoidea cylindrica. *Agass*.....Rouen, France.
Chalk Marl (Cretaceous.)

825. Galerites albo-galerus. *Lam*.....Kent, England.
Upper Chalk.

833. Dictyophyton tuberosum. *Hall*.....Steuben county, N. Y.
Chemung (Upper Devonian.)

842. Hemipneustes radiatus. *Agass*.....Maestricht, Holland.
Upper Chalk.

847. Micraster cor-anguinum. *Agass*.....Kent, England.
Chalk.

860. Ophioderma Egertoni. *Broderip*.....Lyme-Regis, England.
Lias.

861. Ophioderma Egertoni. *Brod*.....Lyme-Regis, Eng.
Lias.

863. Solastor Moretonis. *Forbes*.....Gloucestershire, England.
Great Oolite.

898. Apiocrinus Parkinsoni. *Schloth*.....Bradford, Eng.
Great Oolite.

899. Apiocrinus Parkinsoni. *Schloth*.....Bradford, Eng.
Oolite.

901. Apiocrinus Parkinsoni. *Schloth*.....Bradford, Eng.
Oolite.

904. Astrocoma Cirini.....Cirin, France.
Lithographic Limestone (Middle Oolite.)

911. Crotalocrinus rugosus. *Miller*.....Dudley, England.
Upper Silurian.

917. Encrinus liliiformis. *Schloth*.....Brunswick, Germany.
Muschelkalk (Middle Trias.)

918. Encrinus liliiformis. *Schloth*.....Brunswick, Ger.
Muschelkalk, (Trias.)

919. Encrinus liliiformis. *Schloth*.....Brunswick, Ger.
Muschelkalk, (Trias.)

942. Pentacrinus subangularis. *Miller*.....Boll, Wirtemberg.
Lias.

943. Pentacrinus subangularis. *Miller*.....Boll, Wirtemberg.
Lias.

947. Periechocrinus moniliformis. *Miller*.....Dudley, Eng.
Upper Silurian.

953. Platycrinus Sarae. *Hall*.....St. Louis, Mo.
St. Louis Limestone (Carboniferous.)

954. Pterocoma pinnata. *Agass*.....Solenhofen, Bavaria.
Middle Oolite.

ACALEPHAE.

963. Graptolithus octobrachiatus. *Hall.*
Lower Silurian.

PROTOZOA.

RHIZOPODA.

966. Amphistegina vulgaris. *D'Orb*.....Bordeaux, France.
Miocene Tertiary.

968. Fusulina cylindrica. *D'Orb*.....Ohio and Nebraska.
Carboniferous.

999. Cassidulina serrata.....Austria.
Miocene.

1002. Clavulina communis. *D'Orb*.....Nussdorf, Austria.
Pliocene.

1007. Globigerina bulloides. *D'Orb.*
Miocene; Austria.
Pliocene; Italy.
Living; Adriatic.

1015. Proroporus complanatus. *Reuss.*
Gault.

1036. Siderolina calcitrapoides. *Lam*.....Maestricht, Holland.
Chalk.

1039. Siphonina reticulata. *Reuss*.....Germany.
Miocene.

1043. Textularia conulus. *Reuss.*
Upper Chalk.

1047. Textularia pupoides.....Meudon, France.
Upper Chalk.

1049. Textularia spinulosa. *Reuss*.....Germany.
Miocene Tertiary.

1059. Cristellaria cassis. *Ficht*.....Sienna, Italy.
Pliocene.

1077. Globulina gibba. *D'Orb*.....France and Adriatic Sea.
Tertiary and Living.

1094. Nodosaria inflata. *Reuss.*
Upper Chalk.

1097. Nodosaria oblonga. *Reuss.*
Eocene Tertiary.

1098. Nodosaria radicula. *Lam.*
Gault (Cretaceous.)

1138. Orbitolites macropora. *Lam*.....Maestrict, Holland.
Chalk.

1150. Spirolina cylindrica. *Lam*.....Paris, France.
Eocene Tertiary.

1161. Vertebralina nitida. *D'Orb*.....Grignon, France.
Eocene Tertiary.

PORIFERA.

1164. Amorphospongia ——.....Franklin county, Ky.
Lower Silurian.

1165. Cœloptychium agaricoides. *Goldf*.....Haldem, Westphalia.
Chalk.

1166. Placoscyphia meandroides. *Leym*.....Kent, England.
Cretaceous Greensand.

1168. Polypothecia dichotoma. *Ben*.....Warminster, England.
Cretaceous Greensand.

1172. Scyphia polyommata. *Goldf*.....Streitberg, Wirtemberg.
Middle Oolite.

1184. Siphonia costata. *Lam*.....Warminster, England.
Cretaceous Greensand.

1177. Siphonia pyriformis. *Goldf*.....Blackdown, England.
Upper Greensand (Cretaceous.)

1185. Tentriculites ——.....Birdlington, England.
Chalk.

MISCELLANEOUS.

1204. Cycadoides megalophylla. *Buckl.* (Trunk of a short cycad. Isle of Portland, England.
Wealden.

1206. Dammarites ——, (conifer.).....Burton, Somerset, England.
Inferior Oolite.

1207. Nipadites Burtini. *Brong*.....Schaerbeck, Belgium.
Eocene Tertiary.

1212. Welcome Nugget (gold).....Ballarat, Australia.

1216. Platinum Nugget.....Ural Mts., Siberia.

1237. Rosetta Stone.....Rosetta, Lower Egypt.

1245. Bust of Linnæus, life size.

1247. Bust of Cuvier, life size.

1248. Bust of Geoffroy St. Hilaire, life size.

Bust of Huxley, life size.

ERRATA.

Page 15, lines 3 and 4 from top, for vallies read *valleys.*
Page 15, line 14 from bottom, for Ttrenton read *Trenton.*
Page 33, line 9 from bottom, for continious read *continuous.*
Page 41, line 2 from bottom, after seen, insert *if restored.*
Page 51, line 6 from bottom, for McVee read *McNee.*
Page 53, line 13 from top, for M. read *A.*
Page 58, line 8 from bottom, for Shunard read *Shumard.*
Page 67, line 6 from top, for tickest read *thickest.*
Page 108, line 8 from top, for knoles read *knolls.*
Page 115, line 12 from top for characterzes read *characterizes.*

INDEX.