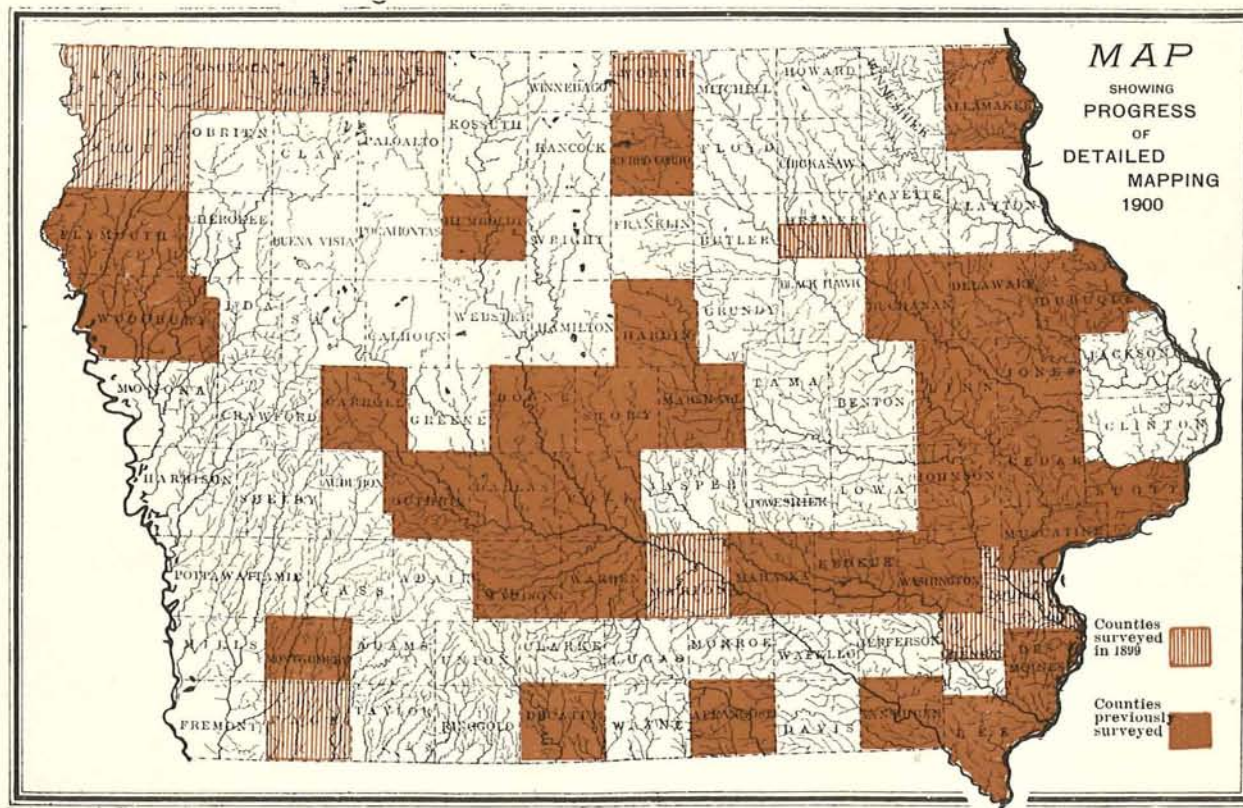

ADMINISTRATIVE REPORTS.



EIGHTH ANNUAL REPORT OF THE STATE GEOLOGIST.

IOWA GEOLOGICAL SURVEY, }
DES MOINES, December 31, 1899. }

To Governor Leslie M. Shaw and Members of the Geological Board:

GENTLEMEN—I have the honor of submitting to you, in accordance with law, my report of the operations of the Iowa Geological Survey for the year 1899. The energies of the Survey have been devoted to carrying out the plans approved by you at the beginning of the working season, and it is hoped that in the extent and quality of the work accomplished all your expectations have been fully met. The corps of investigators engaged upon the work of the Survey during the past year has been somewhat larger than heretofore. In addition to the State Geologist, the Assistant State Geologist and the Secretary, the force has included Dr. S. W. Beyer, Dr. J. B. Weems and Mr. Ira Williams of the State College at Ames; Prof. W. H. Norton of Cornell College, Mount Vernon; Dr. T. H. Macbride of the University of Iowa, Iowa City; Prof. J. A. Udden of Augustana College, Rock Island; Prof. Benj. L. Miller of Penn College, Oskaloosa; Mr. Frank A. Wilder of the West Des Moines High School; Prof. T. E. Savage of Western College, Toledo; and Mr. H. R. Mosnat of Belle Plaine. In addition Mr. Stuart Weller of the University of Chicago spent a short time at Burlington, and Prof. A. V. Sims of the University has kindly undertaken some special tests. Mr. Frank Tate and Miss Charlotte King have each spent some time in preparing illustrations for the reports.

During the year the Survey has directed its attention chiefly to the work of mapping the various unsurveyed counties and to the preparation of reports on the physiography, geology, and resources of the areas so mapped. In all eight counties have been mapped this season, and partial mapping has been done in two more. Revision work was carried on in three counties which had been essentially completed during the preceding season.

In the following table there is given a list of the counties in which mapping has been done. The names of those completed within the year are set in italics, and the names of two, begun during the year, but not yet completed, are set in capitals. In all nearly 24,000 square miles have been so far surveyed, an area which embraces almost half the state. The remaining area will require less work than the portion of the state already surveyed. The location of the several counties surveyed and the distribution of the areal work are shown on the accompanying map (Plate I).

COUNTIES SURVEYED AND MAPPED.

	AREA SQ. MILES.		AREA SQ. MILES.
Allamakee	658	Linn	720
Appanoose	576	<i>Louisa</i>	407
Boone	576	<i>Lyon</i>	587
BREMER	432	Madison	576
Buchanan	576	<i>Marion</i>	576
Carroll	576	Marshall	576
Cedar	576	Montgomery	432
Cerro Gordo	576	Muscatine	437
Dallas	588	<i>Osceola</i>	400
Decatur	576	<i>Page</i>	557
Delaware	576	Plymouth	860
Des Moines	415	Polk	585
<i>Dickinson</i>	404	Scott	455
Dubuque	601	<i>Sioux</i>	769
Guthrie	593	Story	576
Hardin	576	Van Buren	484
HENRY	433	Warren	569
Humboldt	432	Washington	655
Johnson	618	Woodbury	873
Jones	576	<i>Worth</i>	402
Keokuk	576		
Lee	512	Total	23,903

At the close of the last field season some 18,936 square miles had been mapped. It was found impossible, however, to prepare reports on Cedar, Hardin, and Dubuque counties in time for publication in volume IX, and they were accordingly left over for the present volume. This gave an opportunity for a certain amount of revision both in the field and the office, and the reports have gained in value as a result of the delay. This delay has been especially advantageous in the case of Dubuque county, as it will now be possible to incorporate in the report the important results of the mining development of the past season. It also makes it possible to use, as a base map, the topographic sheets covering this area, prepared by the United States Geological Survey. Indeed it was mainly to render this possible that the work was held over, for without a good topographic base map, the detailed geological mapping of a region as rough and broken as the Driftless Area would be altogether impossible. The expense involved, however, in making such a map is far beyond the resources of the Iowa Survey.

The Maquoketa, Anamosa, Elkader and Lancaster sheets of the United States Survey have been but recently completed and have not yet been published. Through the kindness of the director, Prof. Charles D. Walcott, photographic copies of these sheets have been furnished the Iowa Survey for field use and for publication. From them Messrs. Hoen & Co., of Baltimore, are now preparing the base map which will be used in the Dubuque county report. The co-operation of the United States Survey in this matter is very much appreciated and the map will add very greatly to the value of the report.

The work in Dubuque county was undertaken jointly by the Director and the Assistant State Geologist. I took up the stratigraphical and general geological problems, while the assistant investigated the economic phases of the subject. Accordingly Mr. Bain has devoted much time to the study of the problems presented in the mining areas of the county, and particularly to watching the development of the zinc mines

which, under the stimulus of his suggestions, are now opening up with prospects of greatly increased success. Further details will be found in his administrative report.

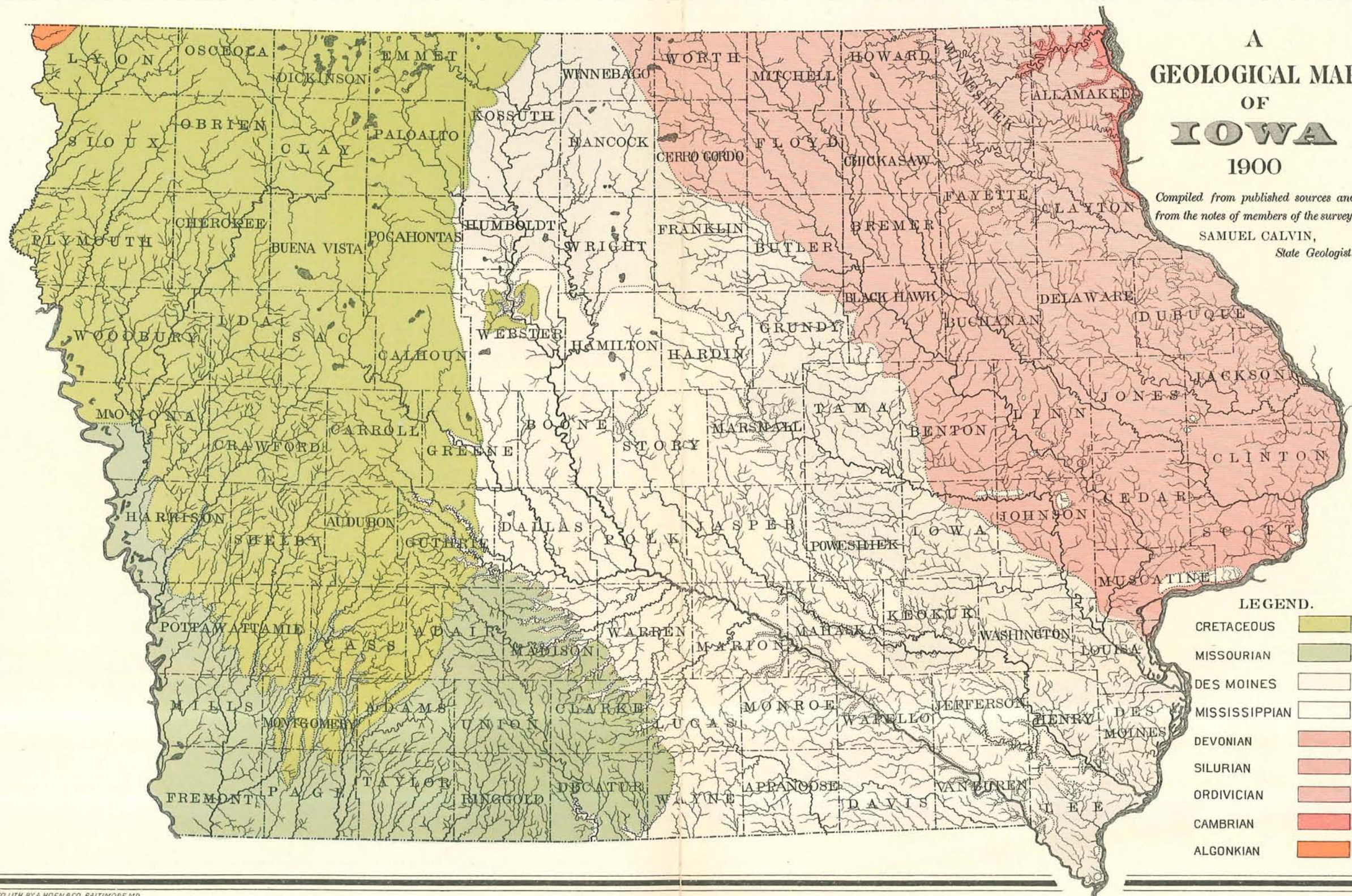
In Cedar county the work begun by Professor Norton last year was carried to completion. Cedar county contains some of the largest and most important quarries in the state and is the seat of an important lime industry. The stone industry of this county in 1898 amounted to \$113,502, and Professor Norton's work confirms the fact that there are large opportunities for expansion. The clay interests of the region are worthy of further development.

In Hardin county Dr. Beyer has devoted considerable attention to the clay interests. There is a very wide variety of clays to be found in the county and the quantity present is all that could be desired. While there are now several plants in operation the clay industry has not been developed to anything like the extent which the character of the material and the commanding position of the county should render possible. The stone industry may also be expected to develop largely. These and the other mineral resources of the region are fittingly discussed in the report upon the county now in preparation.

The new work taken up this year was widely scattered and served to close some of the important gaps in our earlier mapping. Much attention was paid to the western portion of the state, the mapping in the northwest being extended to cover Lyon, Sioux, Osceola and Dickinson counties. The work in the two counties first named was done by Mr. Frank Wilder with the assistance of Mr. Bain. Preparatory to it a general reconnoissance trip was made through several of the adjoining counties. Mr. Wilder's studies have been of great importance in bringing out the fact that the Hawarden beds, heretofore referred to the Ft. Pierre, really belong to the Benton shales and accordingly the limestones and chalk of the Inoceramus beds, as developed in Iowa, are not to be correlated with the Niobrara farther west. They represent instead that

A GEOLOGICAL MAP OF IOWA 1900

Compiled from published sources and
from the notes of members of the survey.
SAMUEL CALVIN,
State Geologist.



portion of the Fort Benton sub-stage exposed in the "Oyster Shell Rim" of the Black Hills. Mr. Wilder has also shed much light upon the vexed question of the age of the drift of the northwestern part of the state. His conclusions, while differing somewhat from those previously held by the Survey, are founded on careful study and seem worthy of every confidence. Probably a final opinion on the subject can not be rendered until more of the region shall have been investigated.

Mr. Wilder shows in his report upon the two counties that the Dakota sandstone, which in South Dakota is such a common source of artesian water, is an important aquifer throughout the region, though not yielding flowing wells. His report is now in the final stages of preparation and will doubtless be ready for publication in this volume.

In Osceola and Dickinson counties Professor Macbride has extended his studies which he made the year before in Humboldt county. The Osceola-Dickinson area is one of very exceptional interest. Here, connected with the drift, are geological problems of highest import. Morainic knobs and kames and undrained marshes, set in level expanses of beautiful prairie land, appear at first sight to be distributed lawlessly over the region, but the difficulties of their peculiar distribution yield to the careful questionings of the trained investigator, and at length something like order is evolved from the seeming confusion. They have all been developed in accordance with definite laws governing the transportation and deposition of material in connection with the movements of glaciers. In this region, too, are found the principal lakes of Iowa, charming sheets of water, surrounded usually by swelling knobs of the glacial moraine which in places is forested and in places grass-covered to the water's edge. Lake and forest and grassy slope unite to form a landscape of rare natural beauty but seldom equaled. The genesis of the lake basins, not less than the genesis of the other topographic features of the region, has long been an attractive problem to

the man of science; in the opportunities for rest, for recreation, for the quiet, joyful stimulation and exercise of the æsthetic sense, which the lakes and their delightful surroundings afford, the general public has found the same region one of great attractiveness. Professor Macbride tells the interesting history of the region in a manner at once clear, comprehensive, and comprehensible; and it is to be hoped that his suggestions for preserving it with what is left of its natural beauty, and converting it into a resort where Iowa's citizens may, for all time, have an opportunity to come in touch with Nature at her best, where physical health and mental tone can be restored to all who are worn and weary from over-exercise of hand or brain, will receive the attention which they deserve.

In the southwest the work left unfinished by the death of Mr. Lonsdale has been resumed. After some field conferences with members of the Survey corps, and after revising and completing the work in Dubuque, I began the survey of Page county. The thickness and succession of the strata composing the Upper Coal Measures in southwestern Iowa, and the relations of these strata to the published sections of Nebraska and Missouri on the one hand, and to those of Iowa on the other, have long been recognized as questions which deserved thorough investigation. As a result of the work in Page county it is shown that, compared with the basal portion of the Upper Coal Measures, Missourian stage,—as developed in Madison county for example,—the deposits here contain less limestone and relatively more of shale and shaly sandstone. This means that shallow-water and marginal deposits are more abundant, and that the conditions for the accumulation and preservation of coal were more favorable in Page county than in regions where the earlier portions of the Missourian stage are exposed. Limestone ledges are here comparatively thin and far apart, while clay deposits reach an unusual development. It is also shown that there are two distinct coal horizons separated by about 130 feet of strata, embracing a few feet of limestone and nearly 120 feet of shales and shaly sandstones.

The rather indefinite line along which the eastern loess and the Missouri river loess meet is found near the western border of Page county, lying chiefly, however, in Fremont. The drift of Page county is, in places, very thick, and it has suffered much more than the average amount of erosion seen in areas south of the Iowan border. The principal stream valleys average nearly 200 feet in depth, cut mostly in the drift; and the sides of the valleys, back to the divides, have been carved into an intricate and branching series of ravines and ridges which cover the whole surface, leaving no part of it in the condition of an uninvaded plain or plateau. The soils are unsurpassed anywhere for the production of corn and other field crops. The coal seams are rather thin, but they are remarkably persistent, and the mining industry is capable of greater development than it has yet attained. With better knowledge of the position of the coal seams the work of prospecting can be carried on more intelligently, and the top works can be located so as to operate the mines with a minimum of expense.

In the central portion of the state Prof. Benj. L. Miller, who has had considerable experience in geological work in connection with the University Geological Survey of Kansas, undertook the mapping of Marion county. His map and report are now in hand and show that the work has been executed with great care. Marion county is located near the central part of the coal field, and while mining is not now as extensive as in certain of the neighboring counties, the coal measures appear particularly rich. With improved railway facilities in the southern portion of the county it may confidently be predicted that valuable mines will be opened up. It is to be expected that Professor Miller's report will prove of material assistance in bringing this about.

Early in the season Professor Udden took up the work in Louisa county, extending over it the survey which he had, the previous season, made in Muscatine county. To the south he connected with Dr. Keyes' mapping of Des Moines county, on the north with my own in Johnson county, and on the west

with that of Mr. Bain in Washington county and Professor Savage, who was working in Henry county. In Louisa county, aside from many interesting problems of general geological interest, Professor Udden made a careful study of the gas field near Letts, which has for some years, yielded heat and light to a number of the citizens. He made a careful test of the pressure in wells and studies of the source of the gas. While his results are discouraging to those who expect high pressure gas to be found by deep drilling, they serve to show that the field may be of some considerable local importance and that the supply is steadier than is usual in the case of drift supplied wells.

In Henry county, Professor Savage devoted some time to a study of the formations present. He is now engaged in studying the fossils and other specimens collected, and with another field season he may be expected to complete the survey of the county.

After he had finished the survey of Cedar county, Professor Norton was transferred to Bremer, where he spent the final weeks of the field season. In Bremer he has an opportunity to carry farther his studies of the Silurian and Devonian, which his previous work in Linn, Scott and Cedar counties has done so much to clear up. At Waverly, Professor Norton was called upon to advise as to the necessity of drilling deeper the well which supplies the city with water. After a careful investigation of the subject he demonstrated that deeper drilling was inadvisable, and a test showing sufficient supply of water present, the purpose was thereupon given up. This made a saving to the city estimated at \$6,000 besides preserving the water supply from mixture with the more highly mineralized and less desirable waters which are found at lower horizons.

In Worth county, Mr. Ira Williams, under the immediate direction of Dr. Beyer, made a detailed survey. Worth lies immediately north of Cerro Gordo county and the same formations are exposed over both. The work in Cerro Gordo was completed in 1897 and Mr. Williams has now extended it to

cover the neighboring county. His report, which is now in hand, shows that his work has been done with great care and it will form an acceptable addition to the series of reports already issued.

In addition to the areal work, there has been an increasing amount of subject work taken up by the Survey. It is important that the people of a given locality should have a report upon the resources of the region. It is, however, equally important that the man who wishes to know something of the coal, building stones, clays, cement materials, iron ores, lead and zinc, artesian waters, or other resources of the state without respect to special areas, should have the best information obtainable made available to him in compact form. If it is necessary to run through a whole series of county reports a stranger is apt to become confused and lose the proper perspective. As a matter of fact the Survey has more calls for information from intending investors, relative to particular subjects than to particular regions, and accordingly an effort is being made to investigate as completely as may be the whole of these particular subjects. With this in view a report upon the coal deposits was among the first prepared by the Survey. Later, reports upon gypsum, artesian wells, lead and zinc and certain of the phases of the building stone industry were issued. Some of these, notably those relating to the building stones and artesian wells, will require further elaboration as a consequence of new development. After the work in the various counties shall have been completed it will be a relatively easy matter to furnish a full and accurate report upon these various subjects. Such reports must necessarily include much of a general nature not appropriate in the county reports. The artesian well report will, it is expected, be from time to time supplemented by notes upon the new wells. Professor Norton is now collecting and collating the material for the first of these supplements. The report upon Dubuque county will serve as an important supplement to Mr. Leonard's paper on the lead and zinc. There are no imme-

diate plans for a special report upon the building stones, though a considerable amount of data for such a report has been collected. Within the year an abstract of this was furnished to Mr. Whittle of Boston, who is preparing a general report upon the building stones of the United States. By this means Iowa stones are assured a proper representation.

The most important move during the year in the matter of subject work has been the organization of a joint commission to investigate the clay resources of the state. In this work the Geological Survey has taken an active part, and is glad to have had the privilege of co-operation with such bodies as the Iowa Brick and Tile Makers' Association, Iowa Engineering Society, the State College, and the State University. The organization and purpose of the commission referred to is set forth in the following circular issued by them and the work done since its organization is detailed in Dr. Beyer's report.

In 1898, eighty-seven out of the ninety-nine counties of Iowa produced some form of clay goods. In all, over \$2,000,000 worth of brick, tile, etc., were manufactured and sold, and 349 establishments were reported. The increase in output of recent years is very marked. The great paving brick industry, with its output valued at from a quarter to a half a million dollars, has grown up within the last few years. In 1897 Iowa ranked third in the production of paving brick, and it is now the most important state west of the Mississippi in that industry. Important, however, as the clay industry has become, it still lags behind the opportunity. There is cheap and abundant fuel. Almost every geological formation in the state yields some clay suitable for manufacture. There are large areas underlain by the clays of the Cretaceous, which yield such superior product in New Jersey and other Atlantic states, as well as at Golden, Colo., and other points in the west. The coal measures, the great storehouse from which Pennsylvania, Ohio and Illinois draw their clay, cover nearly 20,000 square miles in Iowa. They afford a wide variety and a great abundance of clay. The loess, an incomparable material for ease of working and cheap production of standard builders, covers all or parts of sixty-nine counties. Lumber is largely imported, stone is not much in use, the cities and towns are now putting up the second generation of buildings, and everything conspires to favor a good local market. To the north and west is a wide area devoid of fuel, and largely wanting in suitable clays, which must ultimately be good trade territory.

In spite of these favorable conditions, Iowa has for years imported large quantities of clay goods. The bulk of the pottery used in the state, both fine and common, is manufactured elsewhere; the bulk of the fire brick is also shipped in. Large quantities of sewer pipe, paving brick, terra-cotta and fancy building brick, come from outside its borders. This can only come from lack of appreciation of the importance of the local clays, or lack of ability to develop them.

When, in 1892, the Geological Survey was organized, it was seen that the clays would be one of the most important subjects for investigation, and provision was made for their study. Mr. E. H. Lonsdale, at that time engaged in work for the Missouri Geological Survey, was placed in charge of the work, and devoted his attention to it in the years 1893 and 1894. His removal from the state, and subsequent death, left the work unfinished, though many valuable notes had been collected. In the need of pushing the areal work it was found impossible to detail anyone else to this particular subject. In the meantime the work of the county surveyors continued to show the great extent of undeveloped resources, and notes on the extent and occurrence of the various clay beds were continually collected. It was impossible, however, to take up the study of the clays themselves, for want of either proper laboratory equipment or the funds to purchase necessary instruments and supplies.

In the meantime the paving brick industry became more and more important. The city engineers of the state, and other members of the Iowa Engineering Society, had the problems relating to brick paving brought to their attention in the course of their professional work, and at their annual meetings a number of important papers were read bearing on different phases of the subject. The engineers, however, worked almost altogether with the finished material. They could determine the faults of the latter, but had little opportunity to study the causes back of these faults, and none to apply a corrective. It was also found that there was strong need of standard specifications and standard methods of testing. The tests formulated by the National Brick-makers' Association were found to be open to some doubt. The exhaustive work of Marston showed that the cross-breaking test was probably much more reliable than the national committee had rated it. Boynton, after a careful series of tests, found it better to use scrap-iron in the rattler. There was grave question, in particular, whether the National Brick-makers' Association did not rate the soft brick unduly high.

When these matters were brought to the attention of the society at its meeting in 1893, a committee was appointed to consider the entire subject of paving brick and paving brick tests, with a view to some common understanding as to the qualities desirable and attainable. This committee consists of Messrs. A. Marston, of Ames; C. R. Allen, of Ottumwa; C. P. Chase, of Clinton; C. S. Magowan, of Iowa City, and E. P. Boynton, of Cedar Rapids.

The brickmakers of the state have been vitally interested in the development of the paving industry and of the clay industries in general. Individually, they have experimented and have employed experts to study their clays and products. Large sums of money have been spent in an effort to determine the needs and proper methods of manufacture of pavers. So long, however, as there was neither a standard of quality nor any uniform method of testing, the results were uneven. A manufacturer might spend money, time and labor to turn out a brick which he knew would wear well and then have it rejected by some test of which he had never before heard. The necessity for a common understanding became apparent. This matter of paving brick is simply one in which there was this necessity. There were other problems which quite as much needed careful and systematic investigation by experts.

The notable work done in Ohio by the School of Ceramics at the Ohio State University, under the aggressive direction of Prof. Edward Orton, Jr., has attracted much attention, and in Iowa there has been a growing conviction among those interested that a similar institution was badly needed. At Columbus they

have a complete plant for testing clays on a working scale. Soft and stiff mud machines, dry presses, repress, driers and kilns are all in use. Most of the machinery was donated by the manufacturers in the interest of better clay working.

At the winter meeting of the Iowa Brick and Tile-makers' Association, at Sioux City, resolutions were passed commending the work of the Geological Survey and urging the advisability of a fuller investigation of the clays of the state. A committee consisting of Messrs. J. H. Charles, of Sioux City; D. W. Townsend, of Cherokee, and J. B. McHose, of Boone, to which has later been added Mr. C. B. Platt, of Van Meter, was appointed to agitate the matter and, if possible, secure action.

At the Iowa State College of Agriculture and Mechanic Arts, located at Ames, tests of paving brick have been carried on quite extensively, and Professor Marston and his associates were planning to carry on the work the coming year. At the State University, Professors Sims and Magowan were also planning to take up the work. Under the circumstances it was thought that the time for united effort had arrived and a call was issued for a meeting at Ames, June 14th, Representatives of the Engineering Society, Brick-makers' Association, Geological Survey and State University accordingly met with the professors of the engineering department of the college, and a joint commission was organized with Prof. A. Marston, of the State college, as chairman and H. F. Bain, of the Geological Survey, secretary. The visitors were welcomed by President Beardshear, after which there was a general discussion of subjects and methods and a plan of work was adopted.

It was decided as a first step to make a careful study of paving brick with a view to the preparation of a report on the methods of manufacture, the formulation of a series of tests, the adoption of uniform specifications and the collection of data as to methods of laying pavements, its cost and life. The latter portion of the work was placed in the hands of the sub-committee of engineers, who were requested to prepare blanks for the collection of this data. The Geological Survey agreed to detail Dr. S. W. Beyer to visit the various plants in Iowa and study their method of manufacture, carrying on temperature, shrinkage, drying and other tests, and collecting samples for farther laboratory studies. Chemical analyses of the clays are to be made by Dr. J. B. Weems, of the college. Cross-breaking, rattler and absorption tests of the brick are to be made in duplicate at the college and State University, and tensile strength and other physical tests of the clays are to be carried on at the same time. The manufacturers are furnishing the material for these tests and bearing a portion of the expense. It is expected that when complete they will yield very important information and will be of material aid in developing the paving brick industry.

It is hoped that this work will prepare the way to the opening of a complete clay-testing laboratory at Ames. At present the college has no room to spare for the work, nor sufficient available funds to carry it on. It is expected that the work on paving brick will be of sufficient practical importance to induce the authorities to provide the necessary funds for further work.

Before adjournment the following resolutions were adopted:

WHEREAS, The clay resources of Iowa have been shown by the Geological Survey to be vast and varied; and,

WHEREAS, These resources are as yet largely undeveloped; therefore, be it

Resolved, That the plan of investigation here outlined is heartily indorsed and the co-operation of the machine manufacturers, brick-makers, and all others interested is urged. Furthermore, be it

Resolved, That the state be urged to establish at Ames a complete laboratory for the testing of clays and clay products.

The progress of the work is set forth in Dr. Beyer's administrative report, which is appended. The materials collected for testing are now assembled at Ames and Iowa City, and as soon as the crowded condition of the buildings at the former place will permit, a building will be set aside for a special clay laboratory.

Perhaps the most important change in the local mining situation within the year has been the opening of the iron deposits near Waukon. That iron ore occurred here, as at other points in Allamakee, Dubuque and Delaware counties, has long been known. Mr. Ellison Orr described the Iron Hill deposit in the first volume of the American Geologist, and it together with two other beds were located and described in the report on Allamakee county appearing in our volume IV. More than twenty years ago an attempt was made to develop the ore. A number of test pits and drill holes were put down to determine its extent, and numerous analyses were made by Professor Fischer of Milwaukee. His analyses, quoted from the printed prospectus of the development company, gave the following results.

FISCHER'S ANALYSES OF WAUKON ORE.

	BLACK ORE.	YELLOW ORE.	AVERAGE ORE.
Iron oxide.....	.....	.....	56.76
Metallic iron.....	58.54	54.79	...
Silica.....	4.00	5.12	11.02
Water.....	.....	11.92	11.92
Phosphoric acid.....	.....	.13	.30
Lime.....	.....	.70	.70
Magnesia.....	.....	.....	tr.
Alumina.....	.....	.....	tr.
Manganese.....	.....	.....	tr.

Unfortunately, however, the conditions were not ripe for the development of the deposits, for it is the industrial conditions prevailing at any given time, as much as the characteristics of the ore itself, which fix its value.

The present demand for iron ore has attracted attention to the Iowa deposits, and an effort is now being made, with good chances of success, to develop the Iron Hill beds. Through a misprint it develops that the analyses published some time since by the Survey placed the phosphorus entirely too high; an unfortunate error only recently discovered. The decimal was wrongly placed and the correct analyses should read:

	NO. 275.	NO. 278.	NO. 299.
Iron.....	54.32	66.92	58.68
Sulphur.....	.....	.47	.....
Phosphorus.....	.13	.503	.115

This is substantiated by the following new analyses made by Professor Weems from samples taken this fall by Mr. Bain, as well as the average results of some fourteen analyses made by various chemists for Mr. Nehrhood, the lessee of the mine, which place the phosphorus at .13 per cent.

WAUKON IRON.

J. B. WEEMS, ANALYST.

Water and loss on ignition.....	12.34
Silica and insoluble	9.08
Iron oxide Fe_2O_3	68.40
Alumina Al_2O_3	6.08
Manganese oxide MnO} .....	.90
Phosphorous pentoxide P_2O_5.....	.41
Sulphur.....	.91
Sulphur trioxide SO_3.....	.40
Undetermined.....	1.48
Total	100.00
Metallic iron.....	47.88
Phosphorus.....	.18
Total sulphur.....	1.07

The importance of the Waukon ore is found in the fact of the cheapness with which it can be mined, and its fair quality. The ore is a surface deposit, covered with only very light stripping, and when a switch shall have been run to the mine it can be loaded at a very low price per ton. While it is not so high in metallic iron as the red hematites of the Lake ranges it is high for limonite and is exceptionally low in sulphur. The ore is open and porous, so that it is readily smelted. At

present it is being shipped to Milwaukee and used in furnace mixtures, but if the fuel problem can be solved it is not impossible that the region may see some local smelting.

In connection with the activity in iron mining it is interesting to note that the coal mines of the state have had a year of unusual and welcome prosperity. Several new and important mines have been opened, the Whitebreast mine in Monroe county being one of the best equipped in the west. It is gratifying also to state that experiments seem to have demonstrated that in ovens of proper construction certain at least of the Iowa coals can be coked, and arrangements are now being made to build the first battery of ovens at Des Moines. The value of Iowa coal for steaming purposes has been undoubted and certain boiler tests made at the capitol this year show it to be even better than commonly believed, slack coal evaporating 5.01 to 5.55 pounds of water per pound of coal at 212°, which results in a cost for fuel per horse power of 3.07 and 2.76 cents for twelve hours. This is interesting as showing what may be actually attained under working conditions. If any considerable portion of the coal can be prepared for metallurgical work within practical cost limits, it will open a new field for the Iowa mines and prove of great importance to the state.

That Iowa contains large quantities of material such as is elsewhere used for the manufacture of Natural and Portland cement, has been known for some time, and in view of the present large demand for cement it was thought well to make an investigation with a view to determining whether any of this material was so situated as to be available under present conditions. Mr. Bain was accordingly detailed to the work. The preliminary examinations have been completed and the results are so far quite favorable. It is hoped that a full report upon the subject may before long be furnished.

In the meantime the gypsum industry continues in a flourishing condition and makes annually a large contribution to the plaster output of the country. The small number of pro-

ducers in the local field makes it impracticable to publish statistics of this industry without unduly revealing details of a private business nature. With this exception, however, the statistics published by the Survey are very complete. Last year not a single producer of any importance failed to reply. The statistics will be again collected this year in connection with the United States Geological Survey.

The work of collecting soil samples as outlined in my last report has been steadily carried on and the material is now in the hands of the chemist for examination. Professor Weems has made numerous other analyses and examinations for the Survey as detailed in his report accompanying this.

Within the year volume IX of the Survey reports has been printed and distributed. The maps for volume X are now well under way and our first bulletin, "The Grasses of Iowa" by L. H. Pammell, J. B. Weems, and F. Lansom-Scribner, is now in the hands of the printer. The demand for the reports of the Survey has been so great that only volumes VIII and IX can now be supplied except by sale. A change made in revising the code, to which attention has only been called within the last few weeks, directs that 1,000 copies of the annual report shall be bound in the public documents. This will relieve the pressure for copies of the report considerably. The office work at Des Moines has been carried on as before except that during the first months of the year Dr. Beyer assisted in it. A simple laboratory equipment has been put in at Des Moines so that blow pipe and similiar tests can be made there. Many of the specimens sent to the Survey for examination require only such a test as can be made in a few minutes, now that the equipment is at hand.

One of the important results of the work of the Survey has been the bringing together of a strong corps of assistants. With the opportunity which the Survey work has afforded the various members of the corps have acquired familiarity with the methods of research, with the problems in hand and with the field itself. This added experience is reflected in the greater

accuracy of the work and the added rapidity with which it can be executed. The training of a force of even experienced geologists in the needs of a particular field is a work of time, and the results accomplished in this work are not among the least important that the Survey has to present.

I have the honor to remain, gentlemen,

Yours very sincerely,

SAMUEL CALVIN.

REPORT OF ASSISTANT STATE GEOLOGIST.

IOWA GEOLOGICAL SURVEY, }
DECEMBER 26, 1899. }

MY DEAR SIR—I have the honor to submit to you the following report upon my year's work.

Portions of February and March and May were spent under leave of absence, in work in other states. While this shortened somewhat the field season in Iowa it also lessened the season's expense and is believed to have been a distinct advantage to the local work in that it made possible wider comparisons and deeper study of local phenomena. My absence was made possible by the hearty co-operation of Dr. S. W. Beyer who, in the earlier portion of the year, relieved me of much of the usual office work. It was impossible to delegate all of this, however, and as before much time has been taken up with the details of illustrating, printing and binding the work in press during the year.

The correspondence has also been unusually heavy. The revival of business and the ease with which money can be obtained for investment, together with a better understanding of the facilities of the Survey, has brought more than the usual number of inquiries with regard to our mineral resources. It is impossible to answer all of these by means of printed matter, and a single letter often entails a day's search for the desired information. It is believed, however, that in no way is the Survey as directly fulfilling its duty in stimulating the development of the mineral resources of the state, and the letters of thanks for such service received from railways, mine owners, manufacturers, bankers, editors and others, indicate that the work is fully appreciated.

Aside from this general work my own efforts have been devoted mainly to the continued study of the lead and zinc fields of the state and to a search for material suitable for manufacture into Portland and other cements. It is a great pleasure to be able to report that the development work of the year at Dubuque tends to confirm the opinion arrived at last year, that there are important bodies of zinc blende to be mined in the region. The deeper work in the Alpine mine has continued to show good ore. The Avenue Top, Longworthy and Bush mines, all of which have been operated to some extent this year, show good ore bodies with every indication of a continuance of the jack to a considerable depth. The Pikes Peak mine, developed this year by pumping out one of the best known of the old lead ranges, has proven an important producer of jack. At present development work is being carried on on the Locky, Levens, and other crevices with every indication of success, and arrangements are being made to open up a considerable number of others. The Dubuque Ore Concentrating Company has built and equipped a large mill to handle the ores of the district, and it is believed that with better preparation of the ore, much better prices can be obtained. Further details are presented in the report upon Dubuque county, now in preparation for publication in this volume.

In the matter of cement material it is too soon to publish results. Personal visits have been made to, and suites of samples representing average quantities of each layer exposed have been collected from, some seventeen different localities. In addition smaller quantities, collected by myself or other members of the Survey, have been examined from a large number of other points. Some of these samples have been analyzed and the remainder are now in the hands of a chemist who has had large experience in the manufacture of cement. It may be stated that favorable material has already been found, but until the investigations are completed it is thought better to publish no results. The cost of a modern cement

mill is large and its success depends often as much on matters of fuel and industrial conditions as on the mere presence of suitable material. The industry is one requiring high technical skill and it is hoped that before publication an opportunity may serve for acquiring a wider knowledge of the actual manufacture of cement. The work will be pushed as rapidly as possible and a preliminary report will be submitted at the earliest practicable moment.

In the organization of a joint commission for the investigation of clays I had the pleasure of taking part. The work since the organization has, however, been wholly in Dr. Beyer's charge and I have devoted but little attention to it.

In mapping, my personal work has been confined to the completion of certain areas in Dubuque county, left over from last year. I have, however, held field conferences with Professor Norton in Bremer county, Professor Udden in Louisa, Professor Miller in Marion, Professor Macbride in Osceola and Dickinson and Mr. Wilder in Lyon and Sioux. In company with Mr. Wilder I made a bicycle journey from Carroll county northwest as far as Sioux Falls, studying the drift of the intervening region. Mr. Wilder then took up the problem and his report, appearing in this volume, shows how successfully he has attacked it. I have been over most of the region in his company or alone, and would wish heartily to concur in his findings.

Very respectfully,

H. F. BAIN,

Assistant State Geologist.

TO PROF. SAMUEL CALVIN,

State Geologist.

REPORT OF W. H. NORTON.

CORNELL COLLEGE,
MT. VERNON, Iowa, December 23, 1899. }

Dr. Samuel Calvin,

Director Iowa Geological Survey:

SIR—I herewith submit a report of my work for the current year as an assistant upon the Iowa Geological Survey.

During last summer the field work in Cedar county was completed, and that in Bremer also nearly finished. The manuscript of the Cedar county report is nearly written and will be presented in due time for publication in the forthcoming annual report of the Survey. Both of these areas were found unexpectedly rich in geologic interest, and a detailed statement of their resources can hardly fail to be of economic value.

The office maintained by the Survey in the department of artesian wells has steadily increased in usefulness. So far as known no deep well has been drilled recently without consulting with the Survey except in towns where the artesian conditions were already well known from previous borings. Copies of the writer's report on the Artesian Wells of Iowa have been widely distributed throughout the state, and in a number of towns intelligent citizens have made themselves thoroughly familiar with the artesian possibilities of their localities. In nearly every instance where a deep well was under advisement, requests have been made to this office for detailed specifications as to the depth, and the quality and the quantity of artesian water. Several towns have requested a personal examination of the local conditions. Advice has

also been asked as to the prosecution of the work of drilling, and in this way several thousand dollars have been saved to the consulting municipalities. Of still greater value, perhaps, is the professional advice freely given in encouragement of enterprises under consideration.

It is a pleasure to mention the most cordial co-operation which has been furnished in securing records and sample drillings of the recent deep wells of the state. The data thus obtained are of great value, whether they rectify or corroborate the conclusions already reached as to the deeper strata of Iowa, and the artesian conditions dependent upon them. Each well sunk is a test of the accuracy of the geologic maps and sections already published in our reports, and so far the results of the application of these tests has been most gratifying. So nearly, for example, has the depth to the first chief aquifer, or water-bearing stratum, been calculated, that the discrepancy between this and the actual depth at which it was reached by the drill is in no instance, so far as known, greater than the variation in the thickness of the aquifer.

Such is the value of the facts accumulated since the publication of the reports on the artesian wells of the state, that it would seem well to place them on permanent record as a supplemental report in the early future.

Since my last report to you professional advice has been given to owners or projectors of deep wells in the following towns:

Within the last thirty days estimates have been made out for wells at Muscatine and Letts.

At Sumner a deep well is now being put down by the town. Throughout the work this office has been in close touch with it, receiving the fullest information from time to time, and samples of the drillings. Our last communication was early in December, when we advised the town to carry the well still deeper.

The town of Waverly completed in August a fine artesian, discharging between 300 and 400 gallons a minute of pure and

delicious water. The committee in charge consulted with us when the contract was let last February, and at intervals during the prosecution of the work. When the well had reached a depth of 1,718 feet, I was called to Waverly by the council to consult as to the advisability of carrying the well to greater depth. Although the almost unanimous opinion had favored sinking the well several hundred feet deeper, a presentation of all the facts bearing upon the case brought about as great an unanimity to the contrary, and the work was stopped at once. Several complete sets of samples of the strata penetrated were saved and one of these has been given to the Survey. In our published map showing the altitude of the St. Peter, the height of it at Waverly was placed at 200 A. T. This sandstone was reached by the driller at 238 A. T.

Last April the city council at Marshalltown applied for information as to the possibility of obtaining artesian water for municipal supply. It was stated that 2,000,000 gallons daily would be necessary. In reply the distance was stated to the chief aquifers at that station. These were found to lie within practicable limits, but no encouragement could be given that the amount of water considered needful could be obtained.

One, also, of the large manufacturing establishments of the city consulted with this office with regard to the same general questions, and upon study of the chemical constituents of the deeper waters of this region as shown in published analyses in our report, abandoned its project of sinking a deep well, since the waters would probably be unsuited to their specific purpose.

In September last inquiries were made by the city council at Bloomfield as to methods of drilling, reliability of drillers, and artesian possibilities at that locality. In the same month the question was presented of methods to secure in the well now drilling at West Liberty a less heavily mineralized water than that obtained in the first well sunk in that town.

In the course of the survey of Cedar county during the summer, a set of drillings from the Tipton artesian was obtained more complete than that used in our previous reports. We shall thus obtain a better section of one of the deepest borings in the state.

In February the office was asked for an opinion as to the possibility of obtaining artesian waters at Chariton, and in reply a full statement was sent, showing depth to the aquifers, geologic conditions, etc.

In the same month an interesting artesian was completed at Osage. Some two years earlier our advice had been asked on the subject and a strongly encouraging letter stating the geologic situation was published in the local papers. In this letter the probable depth to the St. Peter was estimated at from 700 to 750 feet from the surface. In the well lately finished this formation was reached at about 720 feet. The main aquifers of the Iowa field were not here penetrated, the drill stopping at 780 feet at the base of the St. Peter, with a supply of water which seems to have appeared sufficient to those in charge of the work. If it should prove inadequate to the needs of the growing town, the well can easily be sunk to the more generous water-bearers a few hundred feet below.

The deep well at Crapo Park, Burlington, was not drilled under the supervision of this office and we have been unable to secure samples of the strata penetrated. These, however, were carefully studied by Mr. F. M. Fultz, who published a most complete and valuable paper on the geological section in the 1899 report of the Iowa Academy of Sciences. When the well had reached a depth of 1,520 feet we were consulted by the park commissioners as to the probability of securing a higher head of water by going deeper. It had been thought that perhaps by going to the depth of 2,300 feet artesian water would be encountered under the same head as at Boone and at Des Moines. Such an expectation was without foundation and could not be encouraged, and though the well was sunk to 2,430 feet no additional head was obtained.

At the Iowa Hospital for the Insane at Mount Pleasant a well was finished last year of which a record has been supplied, and it is promised that a set of sample drillings will be furnished for examination. At the same time several citizens of Mount Pleasant consulted with us on the question of artesian municipal supply, quality of water, position of well, etc.

Two artesian wells have recently been drilled at Dubuque, two at McGregor, one at Anamosa, and one at Clinton. Of these more or less complete records have been preserved, and will, doubtless, prove of value, although the stratigraphy of each of these localities is fairly well known from previous borings.

Wells are now being sunk at Iowa Falls and at Hampton. At both towns we arranged with responsible persons for complete records and samples of the drillings, and it is hoped that these important borings may make a marked contribution to our knowledge of the deep strata of Iowa. In these, as in all cases similar, those in charge of the work were promptly communicated with and informed that the services of the Survey were placed at their free use.

I have the honor to remain,

Your obedient servant,

WILLIAM HARMON NORTON.

REPORT OF S. W. BEYER.

IOWA GEOLOGICAL SURVEY, }
DES MOINES, Iowa, December 30, 1899. }

MY DEAR SIR—I have the honor to submit the following report of work done by me during the year ending December 30, 1899. During the first quarter of the year my time was occupied thoroughly in the routine work of the office and sharing with Mr. Bain the work of getting volume IX through the press. The work of compiling the mineral statistics of the state for the year was assigned to me. In the capacity of statistician of the Survey several trips were made to the chief mineral-producing centers of the state. The report on the mineral output for 1898 appears in volume IX.

In June, at a conference composed of representatives from the Iowa Brick-makers' Association, Iowa Engineering Society, Iowa Geological Survey, the Iowa State College and the State University, held at Ames, it was decided to undertake an investigation of the Iowa clays, the work to be done jointly by the institutions concerned, the Survey to undertake the field investigations in the collection of both the raw materials and the manufactured products for further investigations in the laboratories of the State College and the University. It was deemed best that for the current year the inquiry be confined to paving brick. It was my good fortune to be appointed to represent the Survey.

The works at Ottumwa, Oskaloosa, Davenport, Burlington, Fort Dodge, Sioux City, Boone, and Des Moines were visited. Experiments were conducted at Boone, Burlington and Des Moines. It was deemed best to study methods actually in

use and to test products not especially made to be tested but as actually put upon the market. A complete history of the clay from the pit to the finished product was desired and could only be obtained by personal observations at the factories. It was believed to be important that the character of the clays and shales should be carefully noted, that the shrinkage be determined volumetrically and by weight and that the conditions of drying and the actual burning temperatures for the various portions of the kiln be ascertained.

With the above facts in mind the pit sections were examined carefully and the different strata noted. The green brick as they came from the machine were weighed, numbered and measured. The brick were again weighed and measured as they came from the drying kiln, and once more when taken from the burning kiln. Seventy-five brick were experimented on. These marked brick were separated into three groups of twenty-five each and placed at three points in the kiln. The first series was placed near the center and at the bottom of the kiln, the second group at the upper central portion, and the third series at the top near the bags and but little or not at all protected from the direct heat of the furnace. A series of Seger's temperature cones were placed with each group. Liberal samples of the separate beds of clays and shales were collected for a study of the physical and chemical properties, and the marked brick, along with an additional number of brick selected from the same place in the kiln, were shipped to Ames to be subjected to various tests known to engineers and believed to determine the qualities of brick. Duplicate series were shipped to Iowa City for similar tests. The work is not far enough along to warrant generalization or the statement of definite results. This much may be said, however, that all of the factories visited utilize a heterogeneous series of clays and shales, varying greatly in composition and structure, that the average shrinkage varies from 20 to 35 per cent volumetrically and from 20 to 25 per cent by weight and that the

burning temperature varies from 1900° F to 2300° F. Complete vitrification is not far from 2500° F.

No work has yet been done on the chemistry and physics of the clays, and testing of the manufactured product is only begun.

One week of the field season was spent completing the work in Hardin county and the report on the county is now well under way.

Very respectfully yours,

S. W. BEYER.

TO PROF. SAMUEL CALVIN,

State Geologist.

REPORT OF J. B. WEEMS.

AMES, Iowa, December 21, 1899.

SIR—I have the honor of presenting the following report relating to the chemical work of the Survey:

During the year the analyses which have been made are as follows:

NO. OF SAMPLES.	NO. OF DETERMINATIONS.
12 samples of rock for determination of phosphoric acid..	12
9 samples of limestone.....	81
5 samples of zinc ores.....	5
1 sample of copper ore.....	1
2 samples of slag.....	22
1 sample of slate.....	9
Total determinations.....	130

All of the above determinations are made in duplicate. In addition to the above there has been other work on the co-operative work between the Survey and the Experiment Station in its botanical and chemical sections in an investigation of the grasses of the state. This investigation is now almost ready for the press, and will probably be published in the near future.

The investigation on the soils of the state by the chemical section and the Survey is still in progress and is advanced as much as it is possible to expect considering the amount of routine work of the section.

It may be well to call attention to the practical work of the Survey as a valuable adjunct to the regular geological work and under this consideration the soil work would naturally be placed. The state of Iowa is naturally an agricultural state and investigations which will aid the farmer in coming to

understand the soils, which present some of the most complicated problems, will be of the utmost value to the state at large. There is always an opportunity for valuable investigations of this nature, and it is hoped that in the coming years the Survey will be the means of rendering much valuable aid to the farmers of the state.

Very respectfully submitted,

J. B. WEEMS.

TO PROF. SAMUEL CALVIN,
State Geologist.