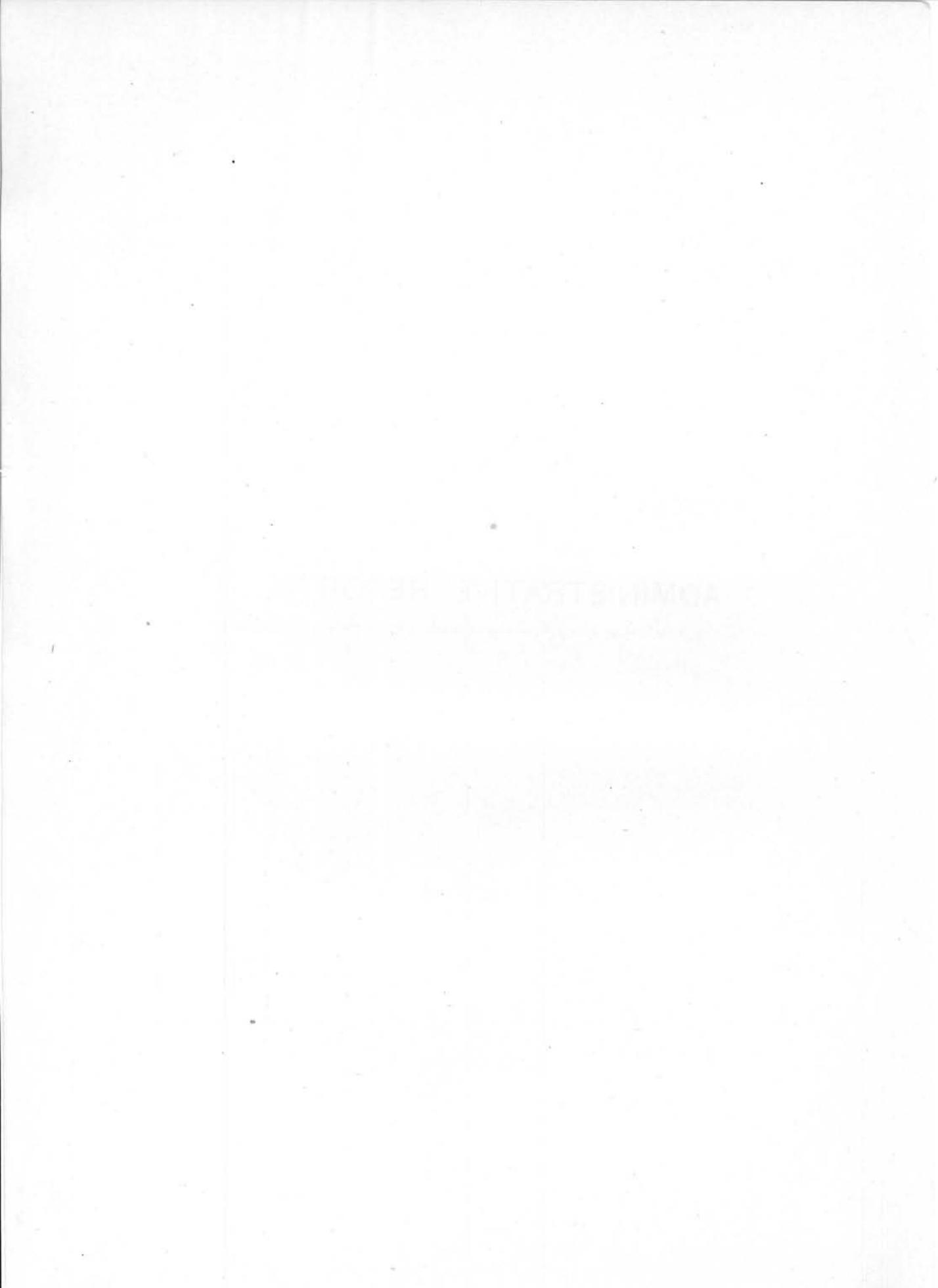

ADMINISTRATIVE REPORTS.



NINTH ANNUAL
Report of the State Geologist.

IOWA GEOLOGICAL SURVEY, }
DES MOINES, DECEMBER 31, 1900. }

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

GENTLEMEN: In accordance with custom and the requirement of law I have the honor to submit, for your consideration, a brief account of the operations of the Iowa Geological Survey for the year 1900. During this year the Survey has been prosecuted along much the same lines as heretofore. This means that, so far as field work is concerned, the greater part of the energies of the Survey has been expended in the direction of areal investigation and mapping, the object being to make a detailed examination of the entire state as rapidly as possible. Examination of the geological formations in the several counties and their detailed mapping are necessary pre-requisites to the correct determination of the geological resources of the state. While, however, areal work has absorbed the larger part of the attention of those responsible for the direction of the Survey, from its organization till the present time, special subjects have not been entirely neglected. Early in the history of the Survey there was published a special report on coal giving all the information in relation to the distribution of this important mineral which could be secured up to the date of publication. The

sixth volume of the present series of reports was devoted exclusively to special studies, that on the artesian wells of Iowa being the most extensive and in some respects the most important. Since the date of that publication Professor Norton has continued to collect data relating to the artesian supplies of the state as new wells have been bored. He has personally visited localities while the work of boring was in progress. He has frequently been called on for professional advice concerning the advisability of stopping the work at a certain stage or of proceeding to greater depths. His services have resulted, in some cases, in saving much unnecessary expense to the communities interested; in other cases his advice has resulted in giving communities a larger and better water supply than would have been secured if their original plans had been carried out. A supplementary report on artesian wells, giving the information collected since the publication of volume VI, will appear at an early date. The economic value and importance of such statistics become greater with every increase in the number of wells studied. The interpretation of the data becomes more precise and reliable, and the information collected can be applied to new cases with greater certainty.

A paper giving the results of careful studies on the lead and zinc ores of the Dubuque region, by Professor A. G. Leonard, also appeared in the sixth volume. The subject of lead and zinc was again taken up in connection with the geological survey of Dubuque county. Mr. Bain, who had this particular part of the work in hand, reviewed the subject exhaustively, availed himself of all the information which had been previously collected, personally examined all the old workings to which he could gain access and studied thoroughly the newer developments, devoted much attention to the genesis of the ore bodies and the conditions which led to their accumulation, and thus was able to present a report treating with great fulness all the historical, scientific, economic and practical phases of the subject. The Geology of

Dubuque County, including a discussion of the minerals and mining problems referred to, appears as a part of volume X.

Dr. Beyer, with the hearty co-operation of all the clay workers of the state and using an expensively equipped laboratory provided by the State College of Agriculture, is preparing a Monograph of Iowa clays, their geological and geographical distribution, their qualities, the uses to which they are best adapted, and the methods of treatment required in each particular case. He has had the work in hand for two years or more, and such are the extent and nature of the problems involved that it will take some time yet before the investigations can be satisfactorily completed. Studies of materials suitable for the manufacture of Portland cement were continued by Bain and Wilder, but we have not yet had reports on all the samples collected and submitted to experts for examination.

The corps of investigators employed during the past season in areal work included Calvin, Wilder, Norton, Udden Macbride, Savage and Miller. Besides the persons named, two volunteer assistants have taken up special work in connection with the soils and drift deposits of certain areas. Mr. H. R. Mosnat, whose volunteer work on the artesian wells of the Belle Plaine area made an acceptable and valuable contribution to volume IX of the Survey reports, has been studying and mapping the Iowan drift margin in Tama and Benton counties, and Mr. George L. Schoonover has undertaken the thorough investigation of the Pleistocene deposits of Jones county. Owing to the withdrawal of Mr. Bain, to whom a large share of the work of supervision had formerly been assigned, I found it necessary to spend the greater portion of the working season in field conferences with other members of the corps. Webster, Tama, Benton, Linn, Pottawattamie, Montgomery, Clay, O'Brien and Jones counties were visited and some time spent in each; and the remainder of the field season was devoted to a review of Page county and efforts to

correlate the beds exposed in Page with those of adjoining areas.

Mr. Wilder completed the field work in Webster county and submitted manuscript maps and report. It is his wish, however, that the publication of the report be deferred for the present in order that he may avail himself of the opportunities offered by a year's residence and study in Europe to visit the great gypsum mills of Germany and France and learn methods of handling and manufacturing which may prove serviceable to those interested in the gypsum industry in Iowa. The possible gain in the value and completeness of the report more than justifies the short delay, and Mr. Wilder's wishes in this respect may well be granted. Professor Norton has completed the manuscript and map for his report on Cedar county, Mr. Miller has finished Marion county, Professor Udden prepared the map and manuscript relating to Louisa county for the engraver and printer respectively, and took up field work in Pottawattamie county. This work he completed early in the season and will have the report on Pottawattamie ready for publication in the present volume. Professor Macbride's work of last year in Osceola and Dickinson counties was extended in 1900 to Clay and O'Brien. The field work was finished in September, and the manuscript report is about ready for the printer. The work last year dealt chiefly with problems relating to the Wisconsin drift; and the characteristics assumed by this drift sheet in its southward extension have been the special subject of Professor Macbride's investigations during the past season. The erratically distributed moraines, the saucer-like kettle holes, and the beautiful lake basins of the Wisconsin area are features of a topography at once unique and interesting; the Wisconsin drift soil, with its unusually large lime constituent adapting it to the cultivation of a great variety of crops, possesses economic interest which renders the region over which it is distributed well worthy of study and careful mapping. The work of Professor Savage was to finish the sur-

vey of Henry county, which he began last year, and to prepare his notes for publication. The preparation of the report is already well advanced. There was not much field work left to be done by Mr. Miller in Marion county, but the data relating to the few unfinished details were collected and his report is now in hand. The new areal work taken up during the year covered the counties of Webster, Pottawattamie, Clay and O'Brien.

The work of the office has included the usual large correspondence with persons, in and out of the state, interested in the resources of Iowa. The proof reading and other work incident to the publication and distribution of Volume X consumed a great deal of time. Volume X is the largest, and is probably one of the most valuable of the publications so far issued by the Survey. The printing of the volume began late and extended well into the summer, a fact that prevented the accomplishment of as much field work by some members of the corps as might otherwise have been done. The printing of Professor Pammel's monograph of the grasses of Iowa, which the Board ordered published fully two years ago, was taken up by the State Printer after Volume X was off the press, and there is now good reason to hope that it will soon be in the hands of the public, for whom it was prepared.

Two changes in the position of Assistant State Geologist have been made during the year. On the first of March Mr. Bain was given six months' leave of absence without pay in order that he might carry into effect at Dubuque, some plans which seemed to promise much for the advancement of the mining interests of the region. Mr. Frank A. Wilder, a man of fine training and marked administrative ability, was chosen to fill the place from March 1 till September 1, when it was expected that Mr. Bain would be ready to renew his work in the office. Before the expiration of his leave of absence, however, Mr. Bain received offers of larger pay with opportunities for experience and growth in different fields, which

it would have been unwise for him to reject; and so much to the regret of all who had learned to appreciate his splendid qualities as an administrative officer and as a man, he resigned his connection with the Iowa Survey. Mr. Wilder's work was in the highest degree satisfactory, but he had planned to go abroad about the first of September for advanced study in the universities of Germany; and it again became necessary to choose a man for the position. We were especially fortunate in securing the services of Mr. A. G. Leonard who had been connected with the Survey in previous years and had had experience in conducting the affairs of the office during a former leave of absence to Mr. Bain. Miss Newman has continued to fill, with characteristic energy and ability, the position of Secretary which she has held since the organization of the Survey.

The demand for the publications of the Survey exceeds the supply. The tenth volume is about the only one of which there are copies left available for distribution, and if all requests for copies of this had been granted, the edition would have been immediately exhausted. Libraries of colleges, academies and high schools, and all public libraries in the state are supplied with the reports in accordance with the rules relating to the distribution of the volumes; while beyond the limits of the state exchanges are made with state and national surveys, and with scientific associations which regularly publish proceedings. The volumes are also sent to geologists of acknowledged standing and reputation in America and Europe; but by far the larger part of every edition goes to the citizens of Iowa. Each member of the Legislature receives a number of copies for distribution among those of his constituents who may be interested in the subjects treated, and private persons making application for reports are asked to get their requests indorsed by members of the Legislature in their respective localities. The object is to insure as far as possible the placing of the volumes in the hands of persons who will intelligently use them. The in-

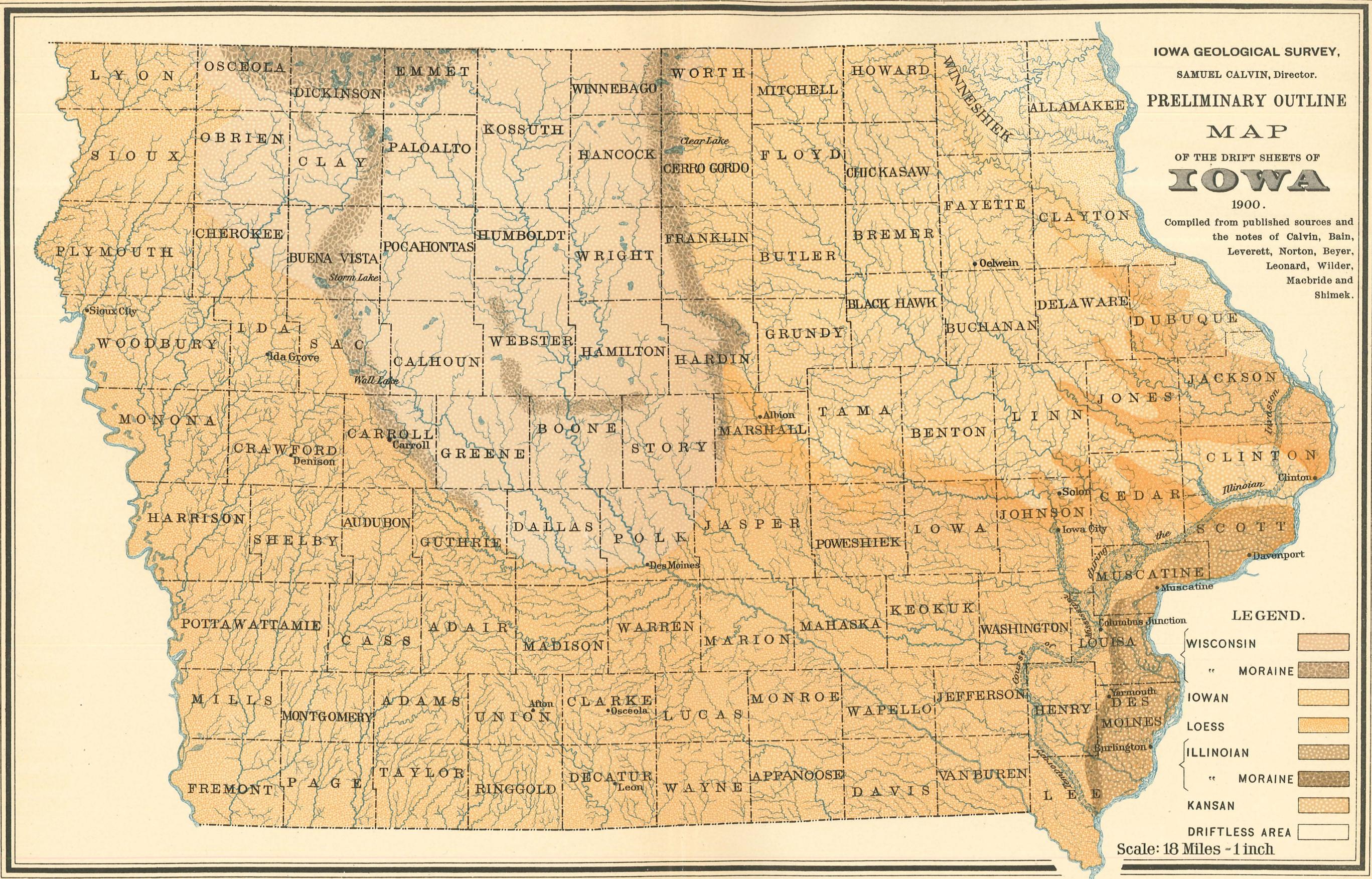
IOWA GEOLOGICAL SURVEY,
SAMUEL CALVIN, Director.

PRELIMINARY OUTLINE

MAP
OF THE DRIFT SHEETS OF
IOWA

1900.

Compiled from published sources and
the notes of Calvin, Bain,
Leverett, Norton, Beyer,
Leonard, Wilder,
Macbride and
Shimek.



LEGEND.

- WISCONSIN
- " MORAINE
- IOWAN
- LOESS
- ILLINOIAN
- " MORAINE
- KANSAN
- DRIFTLESS AREA

Scale: 18 Miles - 1 inch

creasing use of the separate county reports in connection with the study of Physiography and Geology in high schools is an encouraging fact, since, if the practice could become universal, the men and women into whose keeping the control of affairs must soon pass, will be able to look upon the geological resources of the state with intelligent judgment as to what lines of development may be entered upon with fair prospects of success, and what propositions looking to the discovery of desirable geological products are hopelessly absurd.

It is a source of constant wonder and surprise that, notwithstanding all that has been said and written, there are yet persons of influence, intelligent beyond the average in all other respects, who entertain the crudest conceivable notions concerning the geology of the state and the distribution of its mineral resources. The highest natural gifts and the broadest scholarly training and business experience seem to be altogether ineffectual, in the absence of some training in the principles of geology, to protect men from the most amazing fallacies as to what may or may not be found below the surface of the ground. Samples of yellow mica from decayed Kansan boulders, or iron pyrites from shales or limestones, are received almost weekly from persons who imagine they have discovered gold in Iowa. Small flakes of brass worn from the working parts of pumps or other farm machinery, are among the causes which have led to repeated reports of discoveries of gold in a region where not a single condition favorable to the presence of the precious metal exists. Probably the most wild and unjustifiable of all the crude beliefs respecting geological resources is that which holds to the conviction that by going deep enough the drill is sure to find something of value, no matter at what point the work of boring is commenced. There are numerous wise persons in every community, estimable, influential and in the highest degree public spirited, who are fully convinced that the question, for example, of finding coal in their special locality

is simply a matter of the depth to which the explorations are carried. Rock oil and natural gas are recognized as desirable products in every progressive community, and every such community contains persons, in other respects intelligent, who are ready to stake their own fortune and that of their nearest friends on the belief that oil and gas are everywhere underneath the surface, and that their sources can be tapped with the drill, provided only there is sufficient capital to keep up the process of drilling long enough.

But is there no gold in Iowa? Men certainly have found some. Coal occurs in certain localities in the state, why are the chances not equally good for finding it in all other localities? Why is it not a good business venture in Iowa to explore the depths of the earth for gas and oil, when fortunes are made and cities are boomed by the discovery of these desirable products in other states? Why is it not a proper function of the Geological Survey to bore test holes in different localities in order to settle the question of the presence of oil and gas beneath the surface? To answer these questions fully would require much space and would involve a discussion of some of the most elementary principles of geology. Let me try as briefly as possible to present the facts necessary to an understanding of these subjects for the benefit of the non-geological reader.

Native gold, metallic gold, free gold—by whatever name it may be designated—occurs chiefly under two conditions. First, it is found in veins in the crystalline rocks. Such rocks are generally very old; they are fundamental; they occur at the surface in a broad belt around Hudson Bay—none of the newer or later formed rocks being present in that locality—and they extend down into northern Michigan, northern Wisconsin and northern Minnesota. They have been forced up near the surface and have been subsequently exposed by erosion in all mountain regions. As a rule, it is in mountain regions that gold is associated with them, for it is here that they have been fissured by the strains and move-

ments which gave rise to the mountains. Various minerals have been concentrated in the fissures by circulating waters—the waters being more efficient if warm and alkaline—and among the minerals so concentrated we sometimes find gold. Gold-bearing veins in the crystalline rocks are the basis of all the lode mining; but it must be kept in mind that only a very small proportion of all the veins referred to carry gold. Now there are no true crystalline rocks anywhere near the surface in Iowa. All such rocks here are deeply covered with newer rocks of sedimentary origin. These sediments were laid down, one on the other, in slow and orderly succession, on ancient sea bottoms, in precisely the same way, and of precisely the same materials as the beds of mud and sand and limy ooze which are today accumulating on the marginal bottoms of the modern seas. Such rocks contain no gold-bearing veins, and hence it must be obvious that there can be no lode mining for gold in Iowa. In the second place, free gold occurs in placer mines. Placer mines are simply sheets of disintegrated rock material which has been strewn over the surface, usually along river valleys, by the action of flowing water. The rocks of mountains decay and are worn away by air, storm waters, frosts and other agents; the gold-bearing veins, if there are any, decay with the rest; the gold is freed from the matrix in which it was embedded, and the loose materials, gold and all, are gradually washed down to lower levels. The placer miner simply separates—by some convenient device—the gold from the loose clay and sand and gravel with which it is accidentally associated. It must again be obvious that, except in regions where there are gold-bearing veins, there can be no placer mines worth considering. From all this it will be easy for anyone to estimate the probability of finding gold in such a state as Iowa.

In apparent contradiction of all that has just been said it must be acknowledged that gold is occasionally washed out of the sand banks and river gravels within the limits of our state. Spread over the sedimentary rocks and forming our

soils and subsoils, are sheets of drift which were transported and distributed by glaciers coming from the north. Some of the materials forming the drift at any given point were carried long distances, from away beyond the national boundary. In northern Minnesota and on the other side of the boundary line, in the Rainy Lake region, are quartz lodes carrying free gold. The ice sheets brought disintegrated materials from this region, as they did from all others over which they passed, and spread them out as part of the drift of Iowa. Some particles of gold came with the rest, and it is possible occasionally to discover some of them by panning carefully the loose surface materials. A resolute, industrious man, working persistently year by year, might possibly accumulate one or two dollars' worth in the course of a lifetime; but the business cannot be recommended as a profitable means of employing one's time. The resident of Iowa who imagines he has discovered a gold mine on his home farm is certainly basing his judgment on deceptive appearances of some kind.

To understand the situation in respect to coal a few things must be kept in mind. First, as every miner knows, the coal is interbedded with sedimentary rocks, usually with sandstones and shales. Second, sedimentary rocks were laid down, one on the other, one after the other, in slow succession; and so the history of rock deposition in Iowa embraces a very long period of time. This history is almost complete from a period earlier than the introduction of life on the globe to times when land plants and animals were well developed. Third, coal was formed from land plants of certain types, the plants being preserved so as to be transformed into coal only under peculiar and favoring conditions. Fourth, coal plants did not come into existence until long after the beginning of the record preserved in the geological strata of Iowa. The older rocks, therefore, can contain no coal, because they were laid down long before any coal plants grew. All the rocks indicated on the geological map, Plate II, in Volume X, as Algonkian, Cambrian, Ordovician, Silurian, Devonian, and

SYSTEM	SERIES	STAGE	A.T.	ROCK
CARBONIFEROUS	UPPER CARBONIFEROUS or COAL MEASURES	Des Moines		SHALES OF VARIOUS COLORS NON-CALCAREOUS IN PLACES CARBONACEOUS
			873	
	LOWER CARBONIFEROUS or MISSISSIPPIAN	Saint Louis and Augusta		208 178
Kinderhook			13	SHALES, IN PLACES HIGHLY CALCAREOUS
DEVONIAN			-01	LIMESTONE, LIGHT BUFF LIMESTONE WITH GYPSUM
SILURIAN	ONONDAGA ?		-337	LIMESTONE, MAGNESIAN, CHERTY GYPSUM AND SHALE
			-497	LIMESTONE WITH SOME GYPSUM
	NIAGARA	Niagara - Clinton Hudson River	-574 -607	LIMESTONE, CHERTY, ARENACEOUS DOLOMITE SHALES (MADOKETA)
ORDOVICIAN	TRENTON	Trenton		DOLOMITES, YELLOW, BUFF AND BROWN, OFTEN CHERTY
	CANADIAN ?	Onyota	-1115	SHALES, GREEN DOLOMITE
			-1154	SHALE, GREEN, FOSSILIFEROUS SANDSTONE, WHITE DOLOMITE, ARENACEOUS SHALE
		-1277	SHALES AND DOLOMITE	
			-1272	ALTERNATING THIN BEDS OF SANDSTONES AND DOLOMITE
			-1547	DOLOMITES OF VARIOUS TINTS, OFTEN CHERTY
CAMBRIAN	POTSDAM	Saint Croix		ALTERNATING STRATA OF SANDSTONES, DOLOMITES AND SHALES
				SANDSTONE, CLOSE GRAINED, GLAUCONIFEROUS
				DOLOMITE, SILICEOUS, GLAUCONIFEROUS
				SANDSTONE, SACCHAROIDAL, GLAUCONIFEROUS
				MARL, BUFF AND PINK, GLAUCONIFEROUS
			-2129	

GREENWOOD PARK (DES MOINES) WELL SECTION.

Mississippian, are older than any coal. The coal of Iowa occurs chiefly in the Des Moines formation; a little is found in the Missourian. It was while these two formations were in process of accumulation, not before, that coal plants of sufficiently luxuriant growth to count for anything existed in Iowa; and though these plants were abundant, it was only in certain favored and comparatively limited localities that the preservation of the plants took place so as to form coal. The geological formations of Iowa lie one on the other somewhat like the shingles on a roof, except that the oldest and first laid formations extend underneath the rest all the way across the state. The older formations appear successively from beneath the later in going from the southwest toward the northeast. The Cambrian sandstones that are found in the sides of the valleys near Lansing, lie far below the surface at Des Moines. A well bored at Des Moines would pass, in the reverse order of their formation, through all the older beds, and would finally reach the Cambrian at a depth of about 1,600 feet. All these older beds, and all the individual layers of them, are seen in order, one after the other, between Des Moines and Lansing; and so a drill hole at Des Moines could reveal nothing of consequence that might not be learned by careful investigation of the natural surface exposures in the region between Des Moines and the northeast corner of the state.* Explorations for coal in the Mississippian, Devonian, Silurian, or older systems of rocks are foredoomed to failure for the simple reason that these rocks were all completed before a single workable coal seam was deposited, some of them before a single coal plant, or any terrestrial forms of vegetation from which coal might be formed, had come into existence. These formations all lie geologically below the coal as may be seen by consulting

*The Greenwood Park well at Des Moines has penetrated to the Cambrian and has put to actual test the statements which any competent geologist would have made in advance. All the broad details of that boring could have been written out beforehand. The full record of the well, to the minutest details, is given in Norton's *Artesian Wells of Iowa*, Iowa Geol. Sur., Vol. VI, p. 294 *et seq.* Scores of other deep wells scattered throughout Iowa and confirming all that would be inferred from studies of the superficial exposures, are described in the same volume.

Plate III, in which their relations to each other and to the coal-bearing Des Moines formation are correctly indicated. If one could begin in the Mississippian or lower formations underneath Des Moines or in that vicinity, and bore upwards, he might have some chance of striking coal. But boring downwards in any of the formations referred to, whether under Des Moines or at points where the older beds come to the surface in the eastern part of the state, is going in the wrong direction; and the farther the boring is carried, the more hopeless becomes the search. There is positively no coal in any parts of Iowa, which have formations older than the Des Moines shales and sandstones as the surface rock. The finding of coal is not a question of deep drill holes, but is one of intelligent and thorough prospecting of geological deposits of a particular age. If the operation is begun in any formation older than the Des Moines, the drill may go through to Australia or anywhere else without finding a speck of coal.

Petroleum and natural gas are like coal in one particular—they are derived from organic products. They are known to have their origin in dark bituminous shale, in limestones, which are in general of organic origin, in quantities of vegetable matter included in sandstones, in remains of forests buried in the drift, in any accumulations of organic matter which have undergone or are undergoing decay while hermetically sealed from the atmosphere. The marsh gas, which is annually produced by the decay of vegetation at the bottom of ponds, affords an illustration of the origin of one of the products we are considering, familiar to almost every observant person. It need scarcely be said, therefore, that rocks which are older than the introduction of life on the globe can furnish neither gas nor oil; and the fact that such rocks may be reached in Iowa at no great depth makes it possible to explore the whole of the possibly productive series with comparative ease. Owing to their low specific gravity, oil and gas are displaced by descending waters and tend to rise toward the surface. They may, therefore, be

found at some distance above the beds in which they are generated, but it would be very unusual to find them lower down.

The seas were practically destitute of life when the Algonkian quartzites at the base of the Iowa geological column were laid down, and all rocks older than the quartzites were formed under conditions even less favorable. It may be very positively affirmed that explorations for oil or gas below the top of the Algonkian are certain to be fruitless. Above the Algonkian lies a body of Cambrian sediments—mostly sandstones—1,000 feet in thickness. Life was far from abundant in Iowa during the deposition of the Cambrian, though even if it had been never so prolific, it would have counted for little, since sandstone is not a good conservator of the organic matter present in the seas at the time of its accumulation. Sandstones are good reservoirs for the storage of gas and oil after these products have been generated from some underlying productive rock. But there is nothing below our Cambrian from which gas or oil could be derived, and so the probability of finding either below the top of the Cambrian sandstones is so small as to be unworthy of consideration. Overlying the Cambrian are two formations, the Oneota and the Saint Peter, equally as barren as anything below them. When the drill reaches the top of the Saint Peter sandstone, it has practically passed through and beyond all formations in which there is any possible hope of finding the products under discussion. Next in ascending order comes the Trenton limestone, a formation that was laid down on a sea bottom fairly crowded with swarming forms of life. This limestone is impure; it contains a large amount of clay mixed either with the materials forming the layers of stone or laid down as beds of shale between the more stony layers. The Trenton formation was deposited under exceedingly favorable conditions for making it a productive source of gas and oil. It still contains large quantities of bituminous matter which by the slow distillation always going on must yield annually considerable volumes of gaseous or liquid hydrocarbons. At all the exposures of the lower

Trenton, from Dubuque northward, the dry shaly partings between the ledges of limestone afford material so rich in bitumen that it is easily lighted with a match; it burns freely and emits a strong oily odor. Bituminous shale, precisely like that seen in the natural exposures, was brought up from the horizon of the Trenton in the deep well at Washington, Iowa; it has been recognized in other deep wells; the same shale, rich in bitumen, probably underlies the greater part of the state.

If then a great amount of bitumen is stored up in the Trenton limestone and is constantly evolving gas and oil by slow distillation, why are not gas and oil wells as common in Iowa as in the productive regions of Ohio and Indiana? Let it be answered that something more than petroleum-bearing rock is needed in order that oil may be obtained in quantities of commercial importance. It has been estimated by Professor Orton that the rocks beneath the surface over a very large part of Ohio contain at least 3,000,000 barrels of oil to the square mile, and yet not one gallon of this can be secured by the drill without the concurrence of at least two other conditions: (1) There must be a porous reservoir—sandstone or porous limestone—in which the oil or gas may accumulate, and this must be covered with shale or other impervious deposit to prevent the hydrocarbons from escaping to the surface and becoming lost as fast as they are generated. But reservoir and cover alone will not insure a supply. So long as the rocks lie flat or have a uniform dip there will be no accumulations of any importance. (2) The reservoir and cover must present a series of folds beneath the arches of which the oil and gas are entrapped and accumulated under high pressure. Three conditions, therefore, must exist conjointly—the source of supply in some form of organic matter, the porous reservoir and impervious cover, and the arched or folded condition of the beds. It is the last of these conditions that is wanting in Iowa. Our stratified rocks are not folded to any noteworthy extent. The compression and

crushing which gave rise to the Appalachian mountains produced folds as far west as Indiana, and then the effects fade out. Iowa is too far away from other centers of crustal disturbance, such as the Ozark region of Missouri or the great mountain axes of the west; and so the rocks are without the folds which are so essential to the accumulation of the fluent hydrocarbons. Besides the Trenton limestone there are petroleum-bearing rocks in other formations in Iowa, notably in the Carboniferous; but so far as discovery has gone, some of the conditions on which accumulation in commercial quantities depends, are always absent. Usable quantities of gas have been found at a few places in Iowa in the drift. This gas has its origin in the buried forests; beds of sand and gravel constitute the reservoir; and overlying boulder clay is the impervious layer. Near Herndon and Letts are wells of this kind. The volume of gas is small; its source is near the surface; nothing would be gained, but much might be lost, by deeper borings. If either oil or gas is ever found in Iowa in usable quantities, outside the drift, it will be found either in or above the Trenton. There is no possibility of its occurring below that formation. Now, remember that deep wells which have penetrated the whole thickness of the Trenton and gone hundreds of feet below it, are scattered all over Iowa. Every one of these wells, no matter for what purpose it was made, is, in effect, a test hole for gas and oil; and every one of them answers the question of the occurrence of these products in a way that might be inferred from what is known of the geological structure—namely, in the negative. The state has been very thoroughly explored beyond the deepest point at which there is the slightest hope of success, and a thousand other test holes would not make the situation any clearer or the results more decisive. There is always the very remote possibility that there may be a small arch somewhere which has not been pierced by the drill, but the chances of its existence are so few, that if the object is simply to test for gas or oil, it would

be an unjustifiable waste of money to search for it even if holes could be bored everywhere down into the Trenton limestone at the rate of one dollar apiece. The geological structure of the state, in its broader features, is now thoroughly known. The records of the many deep wells, so fully and accurately described by Norton in Volume VI of the Iowa Reports, reveal that structure in scores of places down to the Algonkian; and from the base of the Algonkian to the earth's center, there is nothing but barren, igneous rocks in which drills might be worked eternally without the remotest prospect of finding even so much as a trace of gas or oil.

There is another fallacy which should be disposed of, if it is ever possible to dispose of any of the popular and deep-rooted fallacies concerning what is hidden from ordinary observation beneath the surface of the ground. However it has arisen, there is a wide-spread belief that experts in some way are able to judge of the presence or absence of valuable products by an examination of the topography and general characteristics of the surface of any given region. Unscrupulous persons, taking advantage of this belief, have robbed some Iowa communities unmercifully. Such persons usually own an elaborate outfit for drilling, and naturally they want to keep themselves and their machines employed. The community to be victimized is easily selected. With specious claims of expert knowledge and glib assurance that this hill and that ravine and the relations of the level plain all bear unmistakable evidence of underlying wealth of the very kind that the community for the moment most desires, the requisite amount of money is quickly coaxed from the pockets of public spirited subscribers, the hole is bored, the driller gets his pay, and the community is left to repent its folly at its leisure. Not infrequently it is the public spirited men of the community who take the initiative, and, without knowledge of their own and asking no advice, but firm in the belief that the earth will yield anything desired if we only go deep enough, they proceed with the drilling of test holes on a scale involving the

expenditure of thousands of dollars. The end is inevitable. It is that which invariably follows every ill-advised enterprise in which ascertained facts are ignored. The disappointment may be all the keener when the promoters realize that the facts bearing on the case were easily ascertainable.

The highest living authority on the distribution of oil and gas, the man who has done more than any one else for the successful and profitable development of all the interests related to these two products, declares that the most valuable service which science has been able to render in this connection has been the determination of the fields wherein exploration is hopeless. Iowans will do well to remember that, even in a state as munificently endowed as theirs, there are some things and some favoring conditions which Nature has failed to provide, there are some drafts on Nature's apparently limitless bounty which must go unhonored, there are some enterprises looking to the development of natural resources which in the very condition and structure of things are absolutely hopeless. Let them rather reserve all of their capital and energies for the development of the splendid resources which do exist and not waste any in the useless search for geological products which all enlightened experience shows could not, by any known possibility, be developed in the state.

It is a pleasure here to acknowledge the obligations of the Iowa Survey to the Director and officers of the United States Geological Survey. The national survey has practically finished the topographic work in northeastern Iowa and has thus rendered a service to the geological work in our state, of value more than can be easily estimated. The correct mapping of the geological formations in the driftless area would be altogether impossible without topographic base maps, and the preparation of such maps by the Iowa Survey would mean the expenditure of large sums of money and long periods of delay before work in any part of the driftless area could be undertaken. It is therefore to the generous co-operation of the national survey that we are indebted for the

timely appearance of the Dubuque county report. The mapping of the geology and the presentation of the report in intelligible and acceptable form became possible only through the use we were permitted to make of the United States topographic sheets.

For some years we have been in correspondence with the Soil Division of the Department of Agriculture at Washington, looking to the organization of Soil Surveys in Iowa, but heretofore, owing to the limited congressional appropriations for such work, it has not been possible to send a party into this state. There is now a fair prospect that this work can be begun here and that typical areas of Iowa soils may be surveyed under the direction of the Chief of the Division, Mr. Milton Whitney, during the coming summer. The work will be of the highest practical advantage to the farming interests of the state.

While the museum collections have grown to some extent, there has been no systematic effort during the year to make additions simply for the sake of building up a museum, and this for two reasons. First, we have no space in which to make a display of material, and if it were collected, it would merely remain stored in the packing boxes. Second, the making of collections of any considerable size in the field involves expense of time and money, neither of which can well be spared. Small specimens, when necessary, are taken for study in the office and the laboratory; but making collections on any large scale means extra time in the field, the employment of teams to bring the material to the railway, as well as careful packing before the material can be shipped, and some extra force to care for it when it reaches the office.

Without much expense or effort we are accumulating a reference library of the highest importance. Our exchanges with working geologists and scientific societies and organizations of various kinds have brought a large volume of literature of great value, without which research work in many lines could not be undertaken. The scope of the ground

covered by the regular exchanges may be inferred from the following list:

- Anales del Museo Nacional de Buenos Aires. (Buenos Aires.)
 Atti della Società Italiana di Scienze Naturali e del Museo Civico di Storia Naturale in Milano. (Milano.)
 Annals of the South African Museum. (London.)
 Annals of the New York Academy of Sciences.
 American Mining News. (New York.)
 Bulletin de la Société Belge de Géologie. (Bruxelles.)
 Bulletin de la Société Géologique de Normandie. (Havre.)
 Bulletin de la Commission Géologique de Finlande. (Helsingfors.)
 Bulletin du Muséum D'Historie Naturelle. (Paris.)
 Bulletin of the Geological Institute of the University of Upsala. (Upsala.)
 Bulletin Société Neuchateloise des Sciences Naturelles. (Neuchatel.)
 Bulletin of the Buffalo Society of Natural Sciences. (Buffalo.)
 Bulletin of the Chicago Academy of Sciences. (Chicago.)
 Bericht über die Thätigkeit der St. Gallischen Naturwissenschaftlichen Gesellschaft. (St. Gallen.)
 Bergens Museums Aarbog. (Bergen.)
 Beiträge zur Geographie des Mittleren Deutschlands. (Leipzig.)
 Black Diamond. (Chicago.)
 Brick. (Chicago.)
 Corso di Geologia di Antonio Stoppani. (Milano.)
 Communicacoes da Direccao Dos Trabalhos Geologicos de Portugal. (Lisbon.)
 Coal Trade Journal. (New York.)
 Clay Worker. (Indianapolis.)
 Cement and Engineering News. (Chicago.)
 Clay Worker. (Chicago.)
 Geognostische Jahreshefte. (München.)
 Jahresbericht der königl. Bömischen Gesellschaft der Wissenschaften. (Prag.)
 Le Globe. (Geneva.)
 Memoirs and proceedings of the Manchester Literary and Philosophical Society (Manchester).
 Mittheilungen des Naturwissenschaftlichen Vereines für Steiermark. (Graz.)
 Memorias y Revista de la Sociedad Científica. (Mexico.)
 Materialien zur Geologie Russlands. (St. Petersburg.)
 Mines and Minerals. (Scranton.)
 Mining and Metallurgy. (New York.)
 Mining, (Spokane.)
 North of England Institute of Mining and Mechanical Engineers. (Newcastle-upon-Tyne.)
 Proceedings of the Royal Society of Edinburgh. (Edinburgh.)
 Proceedings of the Geologists' Association. (London.)
 Proceedings of the Royal Society of Victoria. (Melbourne.)
 Proceedings of the U. S. National Museum. (Washington.)

- Proceedings of the Indiana Academy of Sciences. (Indianapolis.)
 Proceedings and Collections of the Wyoming Historical and Geological Society. (Wilkes-Barre.)
 Proceedings of the Rochester Academy of Sciences. (Rochester.)
 Proceedings of the California Academy of Sciences. (San Francisco.)
 Proceedings of the Philosophical Society of Glasgow. (Glasgow.)
 Societa Geografica Italiana Bollettino. (Roma.)
 Sammlungen des Geologischen Reichsmuseums in Leiden. (Leiden.)
 Sitzungsberichte der königl bömischen Gesellschaft der Wissenschaften. (Prag.)
 Stone. (New York.)
 Transactions of the Royal Geological Society of Cornwall. (Penzance.)
 Transactions of the Edinburgh Geological Society. (Edinburgh.)
 Transactions of the Australasian Institute of Mining Engineers. (Melbourne.)
 Transactions of the Connecticut Academy of Arts and Sciences. (New Haven.)
 Vierteljahrsschrift der Naturforschenden Gesellschaft in Zürich. (Zürich.)
 Verhandlung der Russisch-Kaiserlichen Mineralogischen Gesellschaft. (St. Petersburg.)
 Zeitschrift der Deutschen geologischen Gesellschaft. (Berlin.)
 Publications are received from the following countries:
 England, Scotland, Germany, Austria, Hungary, Bohemia, Switzerland, Belgium, France, Italy, Portugal, Russia, Sweden, Finland, Mexico, Argentine Republic, South Africa, Victoria and New South Wales, Australia.
 During the past year the following Geological Survey reports have been received:
 Maryland Geological Survey, Allegany County.
 West Virginia Geological Survey. Volume I.
 Geological Survey of Alabama. Bulletin No. 68.
 Geological Survey of Alabama. Report on the Warrior Coal Basin.
 The Geological and Natural History Survey of Minnesota. Volume V.
 20th Annual Report of the U. S. Geological Survey. Parts I-VII.
 Western Australia Geological Survey. Bulletin No. 4.
 Records of the Geological Survey of New South Wales.
 Jahrbuch der Königl Preussischen geologischen Landesanstalt und Bergakademie. Vols. XII-XIX.

Your attention is invited to the Reports of other officers of the Survey having the charge and administration of special lines of work.

I have the honor to remain, gentlemen,

Yours very respectfully,

SAMUEL CALVIN.

REPORT OF ASSISTANT STATE GEOLOGIST.

IOWA GEOLOGICAL SURVEY. }
DES MOINES, December 30, 1900. }

MY DEAR SIR—I have the honor to submit the following report for the period since I entered upon my duties the first of August. During that month I shared with Mr. Wilder the work of the office including the task of getting Volume X. through the press. Since his departure I have had charge of the office and my time has been devoted to the regular duties of the place.

Early in September the printing of the Bulletin on the Grasses of Iowa was commenced and has gone forward as rapidly as possible.

As in past years numerous letters have been received by the Survey asking for information regarding the mineral resources of the state. There have also been inquiries as to whether or not conditions in certain localities were favorable for finding coal, artesian water and other minerals. Not a few of these letters come from outside the state from those who are looking for favorable opportunities of investment. The work of the Survey in furnishing this information regarding the mineral resources of Iowa is an important one and that it is appreciated is shown by the letters received.

The demand for the reports of the Survey continues and has been so great that the supply of all the earlier volumes is now nearly exhausted and they are to be had only by purchase. In order to show to whom the reports go it may be stated that during the last few months entire or partial sets have been furnished to several large New York smelting and

mining companies; a public library in New Jersey; Mining School in Ontario, Canada, and School of Mines in a western state.

Very respectfully,

A. G. LEONARD,

TO PROFESSOR SAMUEL CALVIN,
State Geologist.

REPORT OF PROF W. H. NORTON, IN CHARGE OF ARTESIAN WELLS.

Dr. Samuel Calvin, Director, Iowa Geological Survey.

DEAR SIR—I have the honor to make you the following report of the work done at this office during the year now ending. With the wider knowledge of the work of the Survey there is an increasing number of applications for information in the department of deep wells and water supply. Our correspondents are artesian well contractors, city councils, railway superintendents, the owners of large farms and industrial plants. To answer these inquiries as to the depth at which water may be found in all parts of Iowa, its probable quality and quantity, would require far more time than is at our disposal were it not for the large amount of information at hand, gathered in the previous work of the Survey. While the maps and charts that have already been prepared are of the greatest value, they do not take away the need of a careful investigation of each individual case presented.

The following is a nearly complete list of those who have consulted the office this year, together with the locality, whose artesian conditions were asked for:

Chicago and Great Western Ry.....	Shannon City.
State Board of Control.....	..Cherokee.
Keokuk Canning Co.....	Keokuk.
M. E. Squire.....	Osceola.
Chas. E. Bigham.....	Cambria.
J. F. McCarthy, Artesian Well Cont'r, Minneapolis.....	Sumner.
J. P. Miller & Co. " " " Chicago.....	Waukon.
U. S. Geological Survey, Washington.....	General.
City Council.....	Mount Ayr.
" "	West Liberty.

City Council	Hampton.
" "	Bloomfield.
" "	Mason City.
" "	Sumner.

Information was obtained by correspondence or personal visit with regard to wells sunk recently in Dubuque, Tipton, Anamosa, Iowa Falls, Newton, Sioux City and Burlington, besides a number of the towns noted in the list of correspondents.

In two instances it was thought necessary by city councils to have an investigation of the problem on the spot. I was thus called during the year to Hampton, to consult as to the advisability of continuing the boring of the city artesian to greater depths; and to Mason City to advise as to best methods of increasing their water supply in order to meet the increasing population. In all instances we have met the most hearty appreciation of the work and service of the Survey.

I have the honor to remain, your most obedient servant.

WILLIAM HARMON NORTON.

Cornell College, December 31, 1900.

REPORT OF DR. S. W. BEYER.

DES MOINES, Iowa, December 31, 1900.

MY DEAR SIR—I have the honor to report the following work carried on under my direction during the year ending December 31, 1900. During the spring months my time was largely devoted to compiling the Mineral Statistics of the State. This work, as in former years, was carried on in conjunction with the Division of Mining and Mineral Resources, of the United States Geological Survey. The statistics for Clay were collected by the Federal Census Bureau and could not be collated and reduced in time for publication in Volume X.

The summer field season and such other time as could be spared from my College duties was devoted to work on the geology and technology of the clays of the state. In this work I was ably assisted by Mr. I. A. Williams on the methods of clay-working and clay-working machinery; by Professor A. Marston on the testing of clays and clay products; and Professor J. B. Weems on the Chemistry of clays. The geological work is well along and could be completed at an early date. The same is true of the tests of clay products. The chemical work is progressing rapidly and satisfactorily, while the testing of clays is little more than begun owing to lack of ways and means. It is the hope of those intrusted with the work on clays to bring it to completion during the current year so that the report will be ready for publication in Volume XII. Respectfully submitted,

Your obedient servant,

S. W. BEYER.

TO PROFESSOR SAMUEL CALVIN, *State Geologist.*

REPORT OF DR. J. B. WEEMS.

AMES, Iowa, January 3, 1901.

Professor Samuel Calvin, Director, Iowa Geological Survey, Des Moines, Iowa:

MY DEAR SIR—I have the honor of presenting the following report for the chemical work of the Survey during the past year. The analytical work is shown by the following outline:

Clay, chemical and rational analysis.	4 samples
Limestone	2 samples
Coal.	1 sample
Water, determination of calcium sulphate	1 sample
Gypsum.....	1 sample
Minerals, qualitative tests	1 sample
Minerals, determination of iron.....	1 sample

At present we have under investigation fifteen samples of clays. These samples are connected with the Clay investigation of the Survey. The prospect for the chemical work in the clay investigation during the coming year promises well.

It is also hoped that during the coming year, it will be possible to begin the work on the Soil investigation, which will be of special interest in many respects besides its chemical relations. Another investigation which I hope will be completed during the year is a comparison of the methods which are at present used for the "rational analysis" of clays.

Respectfully submitted,

J. B. WEEMS,
Chemist.