GEOLOGY OF IOWA COUNTY

BY

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INTRODUCTION

LOCATION AND AREA.

Iowa county is situated in the southern part of the east central section of Iowa. The center of the county is about ninety miles directly west from the town of Princeton on the Mississippi river, while the southeast corner of the county is not more than half that distance from the river at its nearest point at Muscatine. It is about fifty miles east and twenty-five south of the geographical center of the state. Benton county bounds it on the north, Johnson county on the east, Keokuk and Washington on the south, and Poweshiek on the west. It is a square tract embracing sixteen congressional ownships, and on the supposition that the government survey is accurate, should contain 576 square miles or 368,640 acres. As a matter of fact, through inaccuracies in the survey, it contains nearly 369,000 acres. It includes Townships 78-81 North and Ranges 9-12 West of the Fifth Principal Meridian.

PREVIOUS GEOLOGICAL WORK.

Iowa county has not been an attractive field for geological work. It lies just beyond the coal fields of the state, and contains no mineral deposits of economic importance. The indurated rocks are exposed in only a few places, and in a very limited area. In the first study of a territory, the geologist generally directs his attention to the localities where he can conveniently examine outcrops of the indurated rocks, or where there is reason to suspect the presence of mineral deposits. Both these incentives are lacking in the case of Iowa county. Nevertheless there are a number of references to this county in the geological literature of the state. The earliest geologist to discuss the geology of this county was Dr. David Dale Owen. Dr. Owen, in describing a trip up the Iowa river in 1849, mentions certain gritstones found in section 26, Township 81 North, Range

9 West. He also describes the topography along the river and discusses the course of the margin of the Carboniferous limestone across Iowa county*. Hall and Whitney, 1858, speak of the almost total lack of rock exposures in this county, and refer to the bluffs of drift along the Iowa river. McGee, in his monograph on the Pleistocene History of Northeastern Iowa, included this county in the area described, it forming a part of the southern boundary of that area. He makes numerous references to Iowa county, particularly to the peculiarities exhibited in its topographical features as determined by its Pleistocene deposits, the behavior of the Iowa river in the county, and the Carboniferous outlier along the Iowa river. Mr. H. R. Mosnat, in his account of the artesian wells of the Belle Plaine area published in Vol. IX of the Reports of the present Survey, refers to the extension of that area into Iowa county, and describes a number of artesian wells of the area considered.

PHYSIOGRAPHY

Topography

This region, in common with nearly all the rest of the state, is covered with a thick mantle of drift, ranging in depth from a few feet to more than three hundred feet. Whatever topographic features the area exhibits, are expressed almost entirely in this universally distributed accumulation of loose material, which overlies the indurated rocks. Only in a very limited area, and to a very slight extent, do the indurated rocks have any part in forming the surface features.

The area under discussion exhibits topographic features of great interest and considerable variety. The Iowa river, entering the county one-half mile from the northwest corner, meanders in a direction a little south of east through a remarkable alluvial plain, and leaves the county about five miles south of the northeast corner. The flood plain of this river is bordered north and south by loess-covered hills rising from one to two hundred feet above the water level. Toward the north these hills extend

*Owen: Geological Survey of Wisconsin, Iowa and Minnesota, 1852, pp. 88-89, 99.

back from the river plain from one to three miles, ending in an irregular line of spurs and ridges which may be readily followed through Lenox township. These spurs and hills descend upon a gently rolling prairie stretching away to the north beyond the borders of the county. The loess hills south of the river are in most respects similar to those north of it, but more quickly and gently descend to the well drained rolling prairie that forms the southern and western three-quarters of the county.

The northeast part of the county, comprising twelve sections in Lenox township, exhibits for the most part the level or gently undulating topography that is characteristic of the Iowan drift plain. Scattered over the surface are bowlders of gray crystalline granite, such as are found generally distributed over much of the northeastern portion of the state in the area of Iowan drift. This extension of the Iowan drift plain into Iowa county is limited on the southwest by the range of spurs to which reference has been made, extending in a generally northwest-southeast direction. They may be traced from the northeast quarter of section 13, township 81 North, range 9 West, where they enter the county, in a northwest direction through the southwest quarter of section 12, Lenox township, thence in a westerly direction through the central parts of sections 11 and 10, thence in a northwesterly direction through the northeast quarter of section 9, and the southwest quarter of section 4, thence nearly due west across the southern part of sections 5 and 6, thence northwest through sections 1 and 2, township 81 North, range 10 West.

From any part of the comparatively level area of the Iowan drift plain, the traveler may see this conspicuous range of hills bounding his vision toward the southwest. They extend beyond the limits of Iowa county southeastward into Johnson county, and northwestward into Benton county. They mark the limit in this direction of the Iowan ice sheet.

Over the surface of these hills is a covering of sandy loess. This deposit is relatively thick, in places twenty-five and even thirty feet. About a mile south of the residence of Mr. August Schloemann in section 7, Lenox township, the roadway cuts into this deposit, which here exhibits indistinct stratification, to a depth of twenty-eight feet. In other places, as in sections 8 and 9, the road cuts show ordinary Kansan till underneath the mantle of loess. In numerous other places this relation of the Kansan till, overlain by a heavy deposit of more or less sandy loess, is readily seen. Everywhere the surface of the Kansan shows the effects of oxidation and leaching, the work of atmospheric agencies previous to the deposit of the loess. The loessial covering was spread upon a surface that had been long exposed to atmospheric agencies. In other words, these bordering hills of the Iowan area do not differ essentially from the loess-Kansan area in general, except in the thickness of the loess, and in the unusual proportion of sand.

Again there are reasons for belief that the border of the Iowan glacier was exceedingly thin in this region and could scarcely have piled up any considerable accumulation of true morainic material, either by push or dump. Here and there within the Iowan area are isolated groups of knolls or rounded hills, which rise from out the Iowan drift. These seem to be of Kansan age, and suggest the idea that the Iowan ice sheet was so attenuated in this region as to have failed to overcome these comparatively insignificant obstructions. A group of such hills is to be seen in the northeast quarter of section 9, Lenox township, on the Vette farm. Evidence of this thinning out of the Iowan ice sheet is also seen in the comparatively small amount of till spread over this border region. In places the wagon road cuts through the thin layer of Iowan till revealing the old weathered Kansan till beneath. Examples are found between sections 4 and 9, township 81 North, range 9 West. The Iowan plain in this region is not the typical plain seen further back from the border, with its almost level surface, its characteristic swells and sags, its imperfectly drained surface. Instead, one notes in places the undulations, the ravines and ridges characteristic of a region of more mature drainage. The explanation seems to be that the Iowan ice sheet failed completely, here along its border, to obscure the topography of the Kansan surface over which it spread, merely softening its ruggedness, but leaving the older topography partially revealed. If this is correct it would seem that the attenuated margin of the ice had little to do with the bordering hills further than perhaps to furnish the material of the loess which now caps them to a depth of several feet.

Here and there along this border region are also to be seen hills of sand, evidently of eolian origin. These sand dunes are especially well developed in the northern parts of sections 7 and 8, township 81 North, range 9 West.

LOESS TOPOGRAPHY.

The loess hills bordering the alluvial bottom lands of the Iowa river have already been referred to. On either side of the flood

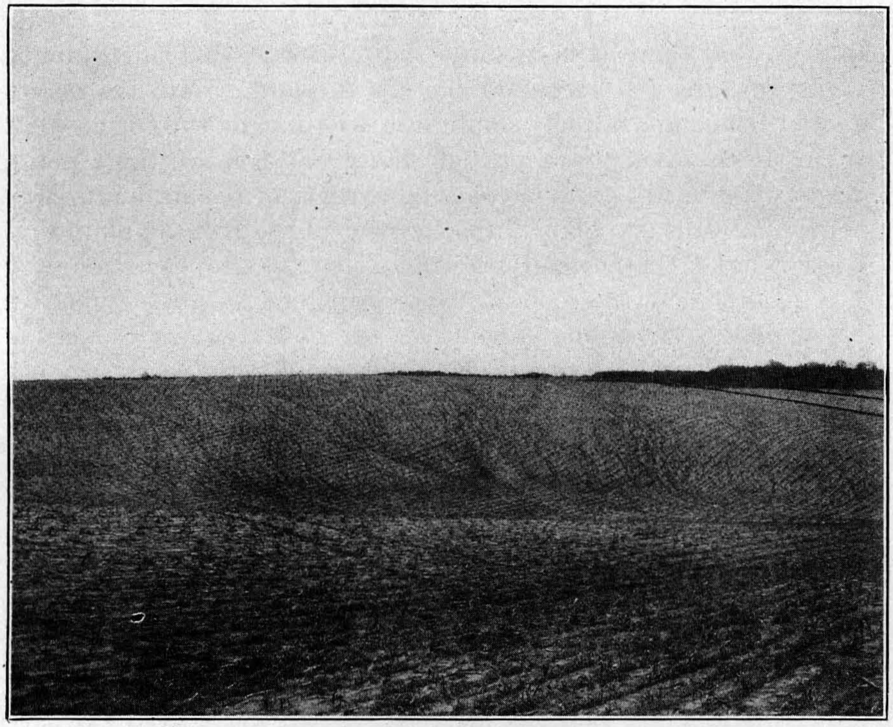


Figure 11. Erosion in a cultivated field of hilly loess. View taken near the north line of section 4, Township 81, Range 11 west.

plain, these hills rise from one to two hundred feet above the river. Not only so, but on traversing the maze of hills north and south of the river, it is found that they often rise a hundred feet above the general level of the plains into which they merge. As already indicated, the loess is everywhere laid down as a deposit upon the surface of hill and slope. It is by no means of uniform thickness, but the depth of the deposit shows no indication of dependence upon erosion. Sometimes the crests, sometimes the slopes of the hills show the thicker veneer. Whereever a natural or artificial section has been made, the loess is seen to be spread over the leached, oxidized and eroded surface of Kansan till. It is certain that if this covering of loess could be removed, there would remain the ancient land surface just as it existed at the time of the advance of the Iowan ice sheet. The general surface has been elevated by so much as the thickness of the loessial veneer, and thus stands above the adjoining plains. South of the river the mantle of loess thins out gradually, so that there is no definite limit, such as that north of the river, forming the border of the Iowan plain. With the exception of the comparatively small area occupied by the Iowan drift plain, Iowa county is a part of the great Kansan drift plain, which extends far south beyond the borders of the state into Missouri and Kansas. Like all that portion of the Kansan plain that borders upon the newer Iowan plain, its topography is more or less modified by the loessial covering which is spread upon it. Nevertheless, with the exceptions of those regions along the rivers where the accumulation is excessive, the loess has not greatly changed the original topography. One may travel over the southern part of Iowa and find the same prevailing types of topography that are characteristic of Iowa county. Stretching in a broad curve across the central part of the county—from east to west—is what is called "the divide." It is a strip of more level country six to eight miles wide including portions of Hartford, Lincoln, Sumner, Hilton, Troy, Iowa and York townships. Portions of this plain are quite level. It represents the greater part of the original prairie land of the county. The soil is here exceptionally rich and black, the farms are among the best in the county as evidenced by the unusually good farm improvements, and the satisfactions of the farm life, both in return for labor and in the ease with which the work is done, are at a maximum. The roads throughout this region run straight for many miles along the section lines.

If one traverses one of the more level portions of this divide, he will notice that it is moderately well-drained, the run-off from the surface finding its way into shallow swales, which if followed, will be found to unite with similar depressions coming in from the sides, the whole becoming more pronounced, and finally eventuating in a small creek, dry during most of the year, but carrying the run-off from the land during freshets. Followed further the run will be found to unite with others, until a considerable stream is developed carrying water during most of the year and trending toward the northeast or the southeast according, as its destination is the Iowa river to the north or one of the large streams to the south. Thus one passes from the more level middle portions of the divide, north and south to more and more broken and hilly country through which the larger waterways extend.

Similar areas, but of less extent, are found between the larger streams, in other parts of the county. Thus parts of Pilot, Troy and Fillmore townships are comparatively level, forming the interfluvial plain between Old Mans creek and North English river. The town of Parnell is situated in the midst of this plain.

These more level areas give some indication of what the topography of the whole region was originally, as left by the retreat of the Kansan ice sheet. They represent that portion of the original plain upon which the agencies of erosion have done the least work. During the time since the Kansan phase of the glacial period, the chief rivers and streams have been cutting deep into the deposits, widening their valleys and working back their slopes farther and farther, and encroaching more and more upon the level plains between streams. Every tributary is repeating on a smaller scale the same process, and heading back farther and farther into the divide. Thus finally, the divides themselves may become dissected and trenched by the same intricate system of dendritically arranged ravines, and the whole region will have reached the complete maturity of its drainage system.

In contrast with the more level reaches of the interfluvial areas, which formed the prairie land of the county, the country along the streams is dissected into an intricate system of ravines and ridges and hills. These parts of the county were originally wooded, and over much of the county they still remain so. It is true the primeval forests have been largely removed, but fine groves of black, white and burr oak, hickory, maple, walnut, elm, etc., have taken their places.

The following table of elevation of points within Iowa county is taken from Gannett:

TABLE OF ELEVATIONS.

LOCALITY.	ELEVATION.	AUTHORITY.
Amana	721	C., M. & St. P. R. R.
S. Amana	882	C., M. & St. P. R. R.
S. Amana	746	C., R. I. & P. R. R.
Conroy	883	C., M. & St. P. R. R.
Williamsburg	765	C., M. & St. P. R. R.
Parnell	859	C., M. & St. P. R. R.
North English	789	C., M. & St. P. R. R.
Homestead	864	C., R. I. & P. R. R.
Marengo	738	C., R. I. & P. R. R.
Ladora	783	C., R. I. & P. R. R.
Victor	805	C., R. I. & P. R. R.

Drainage

The Iowa river receives all the water of Iowa county. It enters the county one-half mile from the northwest corner and takes a southeasterly course. It forms the natural boundary line between part of Cono and Honey Creek townships, and all of Washington and Marengo townships. Amana township is trenched by it. As it meanders through a broad alluvial plain from one and a half to three miles wide, it is constantly changing its bed. The soft alluvium is easily worn back wherever the current is thrown against it. There is thus a constant tendency to increase the meanders, by the action of the current. This is overcome by a counter tendency which works toward the straightening of the channel. In times of flood the river overflows its low banks. At points where pronounced curves have been formed by the ordinary process of wearing, the swollen flood current fails to make the curve, cuts across instead, and thus forms a new channel. As the flood subsides the old curve may be resumed or the stream may be temporarily divided, part of the water keeping to the old channel and part taking the new, or the course may be at once changed to the new and straighter bed. In any case, sooner or later, the old channel is entirely abandoned and the new adopted. The entrance and exit of the old channels will be silted up in time, leaving an elongated lakelet of water. Thus are formed the so-called oxbow lakes, which are a characteristic feature of all rivers that meander through alluvial flood plains. A section of the Iowa river from Marengo eastward illustrating some of the steps and features of the process, is shown in Pl. XVIII.

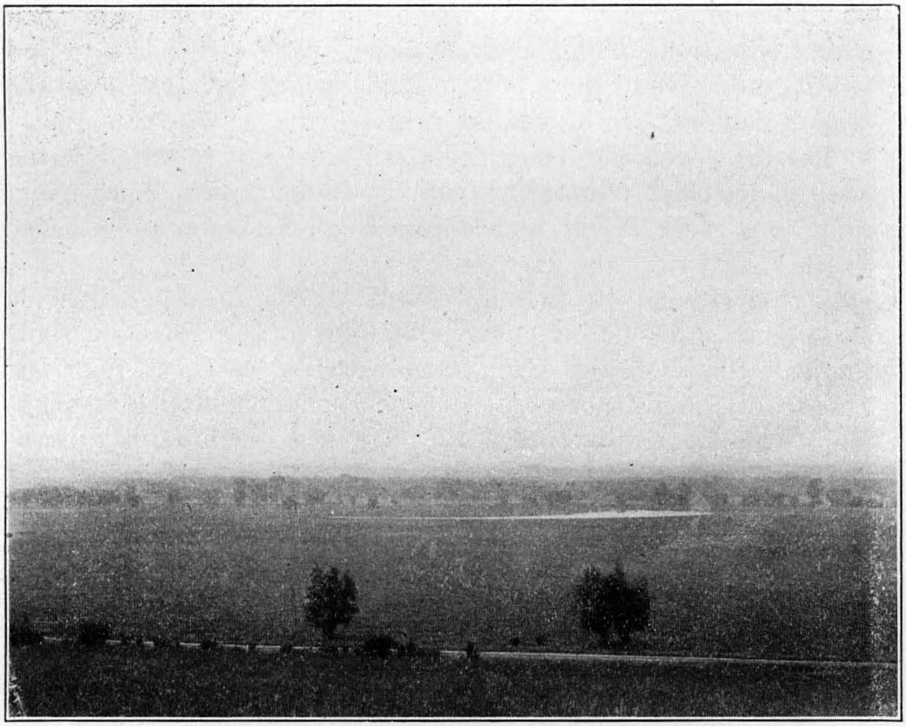


Figure 12. Broad valley of the Iowa river from near Hohe Amana.

In Amana township, the Amana Society has cut a channel from the west side of the township where the river enters to the bend in the river in section 26 of the same township, thus furnishing water power and supply to the villages of Middle Amana and Amana, and controlling to some extent the flood waters of the stream. This is the more effectually accomplished by the partial filling up of a depression in sections 27 and 28. Flood waters are gathered into this basin, preventing the inundations that would otherwise frequently occur.

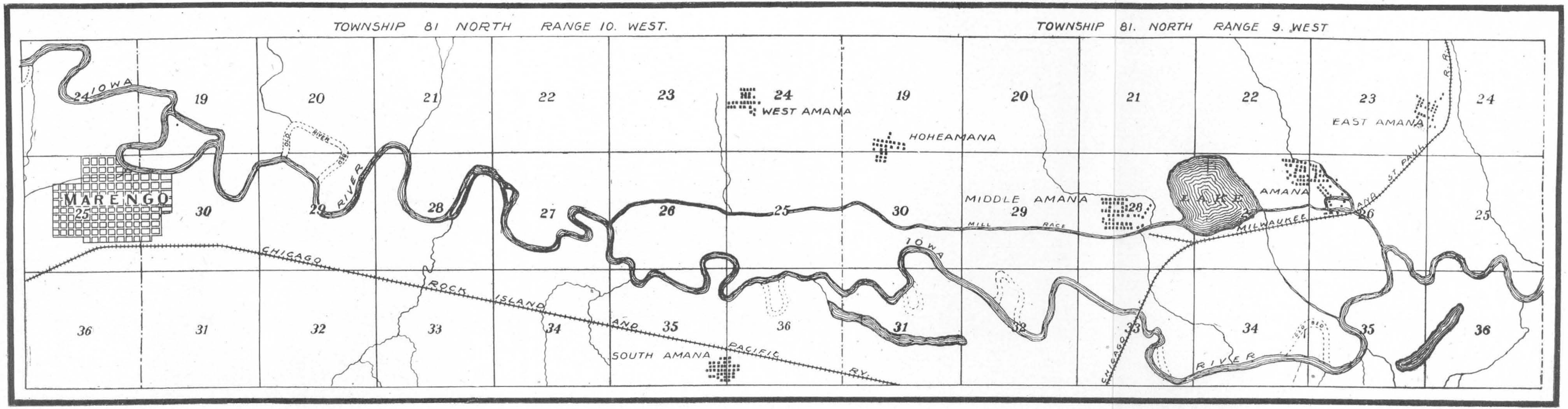
The valley of the Iowa river, as well as the valleys of all the principal streams of the county, are developed in the Kansan drift. Their history evidently dates from the retreat of the Kansan ice sheet. All are now partially filled with river gravel, sands, clays, and silts. These form the broad floors through which the streams now make their way in channels only from five to ten feet below the alluvial surface.

Along all the streams there are indistinct traces of terraces and alluvial benches. The towns along the river are built upon slight elevations of this character, and many of the richest and most productive of these bottom lands, which have rendered the region famous, are of similar origin.

The loess hills bordering the Iowa river are repeated in the case of its chief tributaries, notably Honey creek, Bear creek, Old Mans creek, North and Middle English rivers, and Gritter creek.

The drainage of the townships north of the river is through several small tributaries that flow into it almost at right angles. South of the river, Honey Creek, Marengo, most of Hartford, and the northern parts of Sumner and Hilton townships are drained by streams that flow in a northeasterly direction into the Iowa.

Honey creek heads in swales in section 6 of Hartford township and section 31 of Honey creek township, and flows through Honey Creek township into the Iowa at Koszta. During the spring and at times of heavy summer rains, this creek carries a large amount of water and overflows its low banks in its course across the flood plain of the master stream, sometimes destroying the splendid crops of corn that are grown upon these rich bottom lands. Bear creek and Little Bear creek enter from Poweshiek county and flow in a northeasterly direction through Hartford township to their confluence in section 4 of Sumner township; thence through Marengo township to the Iowa river about one mile northwest of Marengo. The Chicago, Rock Island and Pacific Railroad has availed itself of the flood plain of Big Bear creek for its road bed, leaving at Marengo the flood plain of the Iowa which it follows east of that town. Clear creek has



Segment of the Iowa River in Iowa county from Marengo eastward to the county line.

its sources in Hilton and Troy townships and flows in a southeasterly direction through Iowa township. It becomes a stream of importance in Johnson county.

The southern half of the county is drained by a series of streams which flow southeast almost parallel with the course of the Iowa river. The beginnings of Old Mans creek are found in Hartford, Sumner and Pilot townships. This stream takes a southeasterly course to Williamsburg, thence it flows almost south across sections 10, 15, 22, and 27, thence east through the southern part of York township. It becomes an important part of the drainage system of Johnson county.

Next to the Iowa river, the most important stream in Iowa county is English river with its confluents North English and Middle English rivers. These streams drain the southern group of townships. Lincoln, Dayton and English townships are entirely drained by English river, as are parts of Pilot, Fillmore, and Greene. The North English rises in Poweshiek county and flows in a southeasterly direction through the southern part of Lincoln township, thence across the southwest corner of Pilot, and the northeast corner of English township, to its confluence with the Middle English in section 20 of Fillmore township. It receives Deep creek and Devils run from the north and Jordan creek and Deep river from the south as its principal tributaries.

Middle English river also rises in Poweshiek county and, taking a course almost due east through Dayton and English townships, joins the North English as indicated above. Its principal branch is Gritter creek, which flows almost parallel with it through the southern part of Dayton and English townships, making its junction in section 25 of English township, one mile north of the town of North English.

The English river proper has a comparatively short course within the county. From the point in section 20 of Fillmore township where the North English and Middle English unite, to the point where it leaves the county in section 31 of Greene township, is not more than six miles.

STRATIGRAPHY

With a very few exceptions the whole surface of Iowa county is deeply covered by deposits of Pleistocene and Recent age.

The streams flow through filled valleys and have nowhere cut into the underlying indurated rocks. Certain sandstones of Carboniferous age are exposed in the bluffs on the north side of the Iowa river in Amana township, and limestone of Kinderhook age, not hitherto noted, is exposed in a very limited area in the bank of Price creek at Amana. All these are confined within an area of not more than eight or ten square miles, and are the only indurated rocks exposed within the county. The Pleistocene and recent deposits cover all the rest of the county to a depth varying from a few inches to several hundred feet. What the rocks are which underlie this surface deposit can only be inferred from their relation to the nearest exposures in other counties and from a comparison and interpretation of well records. Putting together all such data the distribution of the indurated rocks within the county may be represented with a fair degree of accuracy. (See map.)

TABLE OF FORMATIONS.

The following table shows the geological formations exposed within Iowa county or believed to underlie the Pleistocene drift.

GROUP	SYSTEM	SERIES	STAGE	FORMATION
Cenozoic	Quaternary	Recent	————?	Alluvium
		Pleistocene	Iowan	Loess Drift
			Kansan	Drift
			Aftonian	Gravels
			Nebraskan	Drift
Paleozoic	Carboniferous	Pennsylvanian	Des Moines	Sandstone
		Mississippian	St. Louis	Limestone
			Osage	Limestone
			Kinderhook	Cherty limestone, shale

DEVONIAN SYSTEM

CEDAR VALLEY STAGE.

There are no rocks of this stage exposed within the county. It is possible that they underlie the Pleistocene deposits in the northeastern part of the county, but as there are no exposures of rocks of Devonian age within several miles of the county line, the matter is entirely conjectural and no Devonian is included in the preceding table of geological formations.

CARBONIFEROUS SYSTEM

Mississippian Series

KINDERHOOK STAGE.

At Amana in the bank of Price creek is an exposure of limestone, the only one within the limits of the county. The area of exposure is limited to one or two square rods. The rock is brown to buff in color, irregularly and thinly bedded, and cherty. Both the chert and the limestone are fossiliferous. *Spirifer biplicatus* and two or three species of Productus are among the fossils. This is the only exposure of Kinderhook rocks in Iowa county. The discovery of rocks of this age so far to the eastward is a matter of surprise, and carries the margin of the Kinderhook terrane much farther to the northeastward than was believed to be the case. It is a general law of outcrop in Iowa that the margins of the terranes run in a northwest-southeast direction. It seems a proper inference that the rocks underlying the drift to the west and south belong to the Kinderhook stage.

Everywhere in the central and northwestern parts of the county the glacial deposits overlie a dark shale of considerable thickness, evidently the upper member of the Kinderhook stage. This deposit is referred to by well drillers as "soapstone," and is dreaded by them as it is barren of water, and often, according to their reports, as much as three hundred feet in thickness. In the southwest part of Benton county the drill strikes the same shale, though its thickness is not so great in that county. It appears as the upper member of the stage in Tama and Marshall counties to the northwest, grading down in those counties into the encrinital limestone.

In the southern and southwestern part of Iowa county, well records show a limestone capping these shales. The Maple Mill Section as reported by Bain,* which is taken as typical of the sequence for the Kinderhook in the northwestern part of Washington county, shows the following formations:

	FEET.
4. Limestone, ferruginous, arenaceous in places, fine grained, red, fossiliferous, cherty	10
3. Gritstone, fine-grained, white to buff, fossiliferous	18
2. Limestone, fine-grained, non-fossiliferous	1-6
1. Shale, argillaceous, dark blue to drab, becoming almost black in places	12

At Wassonville, on English river, the shale (No. 1) seems inter-bedded with the limestone. The deep well at Washington shows eighty-two feet of shales, referred by Calvin to the Kinderhook. Mr. F. L. Pounds of Millersburg, a well driller and an intelligent observer, speaking of well records in the southern part of Iowa county, says: "The lime rock we strike here is not a continuation of the shale, but a distinct formation above the shale."

THE OSAGE AND SAINT LOUIS STAGES.

The limestone overlying the Kinderhook shales south of a line drawn from North English to Millersburg, thence west to the county line, may fairly be interpreted as representing these formations. Their exposures along the English river in Washington and Keokuk counties on the south indicate their presence underlying the drift in the southwestern part of Iowa county.

Pennsylvanian Series

DES MOINES STAGE.

At intervals in the bluffs along the north side of the Iowa river in Amana township is exposed a sandstone of the Des Moines stage. It has a futher extension eastward into Johnson county along the river as far as Knapp creek in Monroe township. Professor Calvin gives the following description of its characteristics, which applies equally well to the exposures in Iowa county:

*Iowa Geological Survey, Vol. V, p. 127.

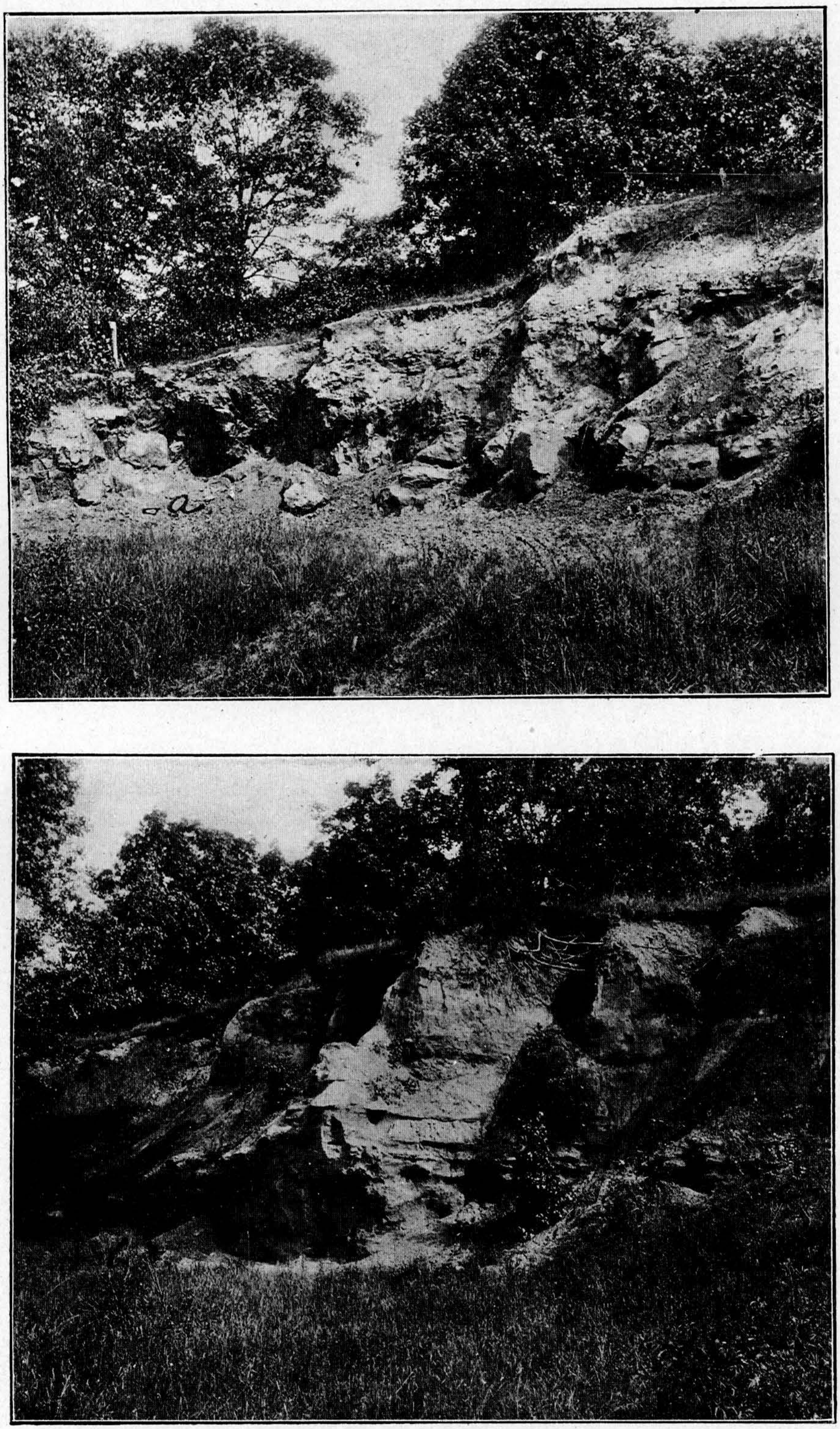


Plate XIX. Des Moines sandstone quarries west of Amana.

p. [170]
(V.20)

"The deposit is here a heavy bedded, and often crossbedded sandstone, composed of coarse grains of silica imperfectly cemented with iron oxide and calcium carbonate. The colors are dingy red and brown with some darker purplish streaks."

This isolated outlier of Des Moines sandstone occupying an area of probably not more than fifty square miles, is one of a number belonging to this stage scattered over eastern Iowa. Similar outliers are found in Linn, Jones, Jackson, Cedar, Clinton, Muscatine, Washington, and Johnson counties.

From the end of this Carboniferous outlier in Amana township to the eastern margin of the great body of the Upper Carboniferous series, which covers so large a portion of southern Iowa, is a distance of not more than twenty miles. It is a natural supposition that originally deposits of this age were widespread over this region, perhaps extending across into Illinois and connecting with the Coal Measures of that state. Professor Norton has thus stated the hypothesis:* "The views of Hall and White that the scattered sandstones were once laid down in isolated basins becomes less probable with each outlier discovered. Those now known are so numerous and widely distributed that they seem rather to support the view that over the depressed area of eastern Iowa the central and western coal fields were broadly joined, or united along a somewhat intricately dissected coast, the most northern known limit of shore or estuarian extension being in Jackson and Linn counties."

At a number of points, the sandstone is quarried for building purposes. Many of the houses in the villages of the Amana Society are constructed of it. It seems very durable above ground, but tends to disintegrate when used for foundations beneath the surface. The effect in buildings is not pleasing, owing to the tendency to discoloration from the contained iron oxide.

Aside from this outlying sandstone of the Coal Measures, there are no known rocks of this stage in Iowa county. The fact that the indurated rocks at no place outside of Amana township have a surface exposure renders it impossible to draw the limits of the geological terranes with certainty. It is possible

*Vol. III, Ann. Rep. Iowa Geological Survey, p. 133.

that other outliers may exist beneath the mantle of drift, although with one posible exception the drill, the only source of information, has given no indication of them. It is also possible that the eastern border of the Des Moines deposits may run through the southwest corner of the county, although again there is no certain evidence that it does so. The strong probability is that it runs several miles farther to the southwest.

QUATERNARY SYSTEM

Deposits of the Quaternary period all but cover the entire county. The bowlder clays, gravel, and sand deposits, and the superficial clays, as well as the extensive river silts, and other materials that fill the river valleys, all belong to the Quaternary.

Pleistocene Series

NEBRASKAN STAGE.

The oldest deposit of the Pleistocene Series in the county is a body of clay intermixed with pebbles and bowlders spread upon the uneven surface of the hard rock. At no point, so far as known, is the deposit exposed at the surface in Iowa county. It is recognized in well sections in various parts of our area. In the northwestern part of the county, lying within the Belle Plaine Artesian area, the drill, after passing through a yellow and a blue bowlder clay, penetrates a layer of sand or gravel, the aquifer for the region, and beneath this strikes another till described as dark in color, becoming lighter on exposure, bearing pebbles and bowlders.

At the time of the first ice invasion, before this ancient bowlder clay was deposited, the surface of Iowa county was covered by a soil derived from the disintegration of the underlying rocks. This surface was trenched by stream-ways cut deep into the sediments that had been laid down in Devonian seas and Carboniferous estuaries. Vegetation grew upon this ante-Pleistocene soil, consisting in part of a forest of gymnospermous trees. These facts are made evident by the inequalities of the surface of the indurated rocks as indicated by well-borings and by the fragments of wood found in connection with the till.

As the ice advanced slowly from the north over the county, the original soil, with its covering of vegetation, was overwhelmed; it was mingled with the material eroded by the ice from the partially weathered and disintegrated rock surface and also with morainic detritus brought down from the regions farther north; and all this loose rock waste of every kind was spread over the land to form the sheet of Nebraskan drift. The tendency was to level up the whole country, the ice sheet wearing down the elevations and filling up the valleys and depressions with the glacial debris. So great, however, had been the inequalities of the surface from the long period of erosion and stream action, that this levelling up process was only partial.

When at the close of this first phase of the Great Ice Age, the climatic conditions began to change and the ice to retreat, the streams probably resumed, to a large extent, their old channels and began to cut their way into the glacial deposits that had partially filled and choked them.

AFTONIAN INTERGLACIAL STAGE.

On the retreat of the Nebraskan ice sheet, there ensued a period of milder climate and the resumption of ordinary conditions. Atmospheric and aqueous agencies resumed their work. Oxidation, leaching, erosion, transportation of rock waste, the formation of soils, and the growth of vegetation ensued in normal order. The striking peculiarity of the time, however, was the accumulation at the surface of vast areas of sands and gravels. It is uncertain whether these are to be considered the result of the closing phase of the Nebraskan ice as it retreated from the country by melting, or whether they were accumulated during the inter-glacial period that followed. Doubtless coarse sands and gravels would naturally result in a general way by the removal of the finer materials through the movement of water from the melting ice as it made its retreat. In any case these deposits are found extensively between the Nebraskan till and the Kansan. In some places the presence of an old soil and forest bed is conspicuous, but in Iowa county the sands and gravels are more characteristic.

These accumulations overlying the Nebraskan drift are widespread. In Iowa county they form an important water bearing stratum. As shown by Mosnat* they form the aquifer for the Belle Plaine Artesian Area, which extends into Iowa county. As a general rule the wells of Iowa county are not sunk below this level, an abundance of water being found here, if not in the sandy inclusions in the Kansan drift above. In a few cases, however, notably in the uplands between the Iowa river and Old Mans creek, the drill passes through these sands without finding water. It is not known that these gravels are anywhere in the county exposed at the surface. The formation varies considerably in thickness and in the character of the deposit. Drillers report a depth of from five to thirty feet of sand and gravel referable to this stage. The material varies from coarse sand to coarse gravel. In some cases these Aftonian deposits rest upon the Carboniferous shales directly, the Nebraskan till being entirely absent. On the Wm. Thomas place, section 32, Hilton township, a body of sand is reported to rest upon soapstone.

The water from these Aftonian deposits is strongly mineralized. It corrodes metals and cements gravel and sand to the iron pipe.

KANSAN STAGE.

At the close of the Aftonian interval, a second extension of the ice carried its margin far toward the south into Missouri and Kansas, and there was spread upon the Aftonian surface a remarkably thick deposit of till, the ground moraine of the Keewatin glacier. The Kansan till in Iowa county varies considerably in thickness. It is a blue clay of rock flour, the product of the great ice-mill, with pebbles and bowlders intermingled. The upper portion, to a depth of many feet, however, has been changed to a yellow or brown color. In Iowa county where this bowlder till comes to the surface its color is brown or yellow. Well drillers describe it as a yellow clay with pebbles. Generally, this is the only phase seen at the surface, but everywhere the drill passes from the yellow till into the blue at an average depth of perhaps forty feet. Along with the oxidation

*Iowa Geological Survey, Artesian Wells of the Belle Plaine Area, Vol. IX, p. 532.

of the superficial portions of the till has gone a process of leaching. The lime constituent of the till has been removed generally from the upper three or four feet, and is frequently found accumulated at lower levels into lime balls or concretions.

A large percentage of the pebbles and bowlders of the Kansan till are not derived from the country rock, but have been brought from a distance. The crystalline pebbles, quartz, greenstones, granites, etc., found abundantly, have been carried hundreds of miles from their source. A considerable proportion, however,

Figure 13. Typical loess—Kansan topography. Seen in section 2, Township 81, Range 11.

consists of fragments of limestone and shale, derived from Iowa rocks, and these are either local or have been carried a comparatively short distance. These pebbles and bowlders are commonly faceted and striated, the work of the ice as it forced them forward over the underlying surface. Almost any roadside cut will furnish excellent specimens of such striation and faceting.

Everywhere the surface of the Kansan till has been deeply eroded. The drainage system of the region has been developed in it, and has already been described. The veneer of loess which generally covers it has not greatly obscured the erosional topography, and in many places disappears entirely, the bowlder clay coming quite up to the surface.

Lenticular layers of sand and gravel are common within the Kansan till. Such layers of sand and gravel form reservoirs for the accumulation of water and are the source of supply for many of the wells of Iowa county.

IOWAN STAGE.

The deeply eroded and oxidized surface of the Kansan till bears witness to the great lapse of time between the retreat of the Kansan ice and the deployment that spread the Iowan till. From the standpoint of geological history as a whole the Glacial Epoch forms but a minor episode in the development of the earth, but measured in years, the length of time required to develop such a topography as the Kansan drift shows, is enormous. But whatever the interval, in course of time the ice advanced again from the north, overspreading a large part of the area from which it had retreated, but not reaching nearly so far southward as before. In the direction of Iowa county its margin at its farthest southward advance stopped just short of the hills along the Iowa river. The margin of this advance has already been traced through Lenox township.

The till spread by this phase of glaciation differs in many important respects from the Kansan. Its thickness in general is not nearly so great, and along its margin, as already shown, it is exceptionally thin, so that it fails to disguise entirely the topography of the Kansan surface on which it was spread. The color of this till is yellow. Nowhere is there any covering of loess upon it, but the pebbles come quite up to the surface. A comparison of Kansan bowlder clay with Iowan will show a contrast in the pebbles and bowlders contained. The Iowan has its bowlders, often of large size, lying usually exposed upon the surface. The Kansan bowlders are smaller and buried out of sight. The bowlders of the Iowan are macro-crystalline and prevailingly light-colored. Kansan bowlders are more often dark colored and fine grained. Iowan bowlders also show far less variety than Kansan.

The Iowan drift sheet gives every evidence of its youth. Its surface is almost uneroded. In typical regions the streams flow almost at the surface in the midst of the plain. No valleys have been formed. Nothing like the maze of dendritically arranged ravines and ridges that are characteristic of the Kansan, is to be seen. The drainage system is in its youth.

An examination of the Iowan till shows further evidence that it is of recent origin as compared with the Kansan. The amount of leaching and oxidation is very small.

LOESS.

Overlying the gravel clay of the Kansan till in Iowa county is generally spread a silt-like deposit, the loess. The name is of German origin and refers to the rather loose, porous texture of the deposits of this character found along the rivers of Germany. The deposit does not appear in the northeastern portion of the county occupied by the Iowan drift, and in some portions of the middle and southern parts of the county the pebbly Kansan clay appears at the surface with no mantle of loess. In general it is thickest near the streams, where exposures may be seen in road cuts or ravines thirty or more feet in depth. It thins out toward the divides and in places disappears entirely. It forms the soil over the larger part of the county.

In composition the loess is a yellow clay with variable siliceous and calcareous constituents. In general there seems to be more siliceous sand in the deposits along the streams than in those farther back. The lime is frequently more or less leached from the loess and accumulated into curiously shaped nodules, called by the Germans, loess kindchen. A further effect of leaching and weathering is to render the deposit less porous and more plastic.

The loess is highly fossiliferous in some localities. In the clay banks of the old brick yard north of Marengo species of Helicina were found. Whatever the origin of the loess, it is generally conceded that a large part of the materials of our local deposits have been derived from the Iowan till. The age of the deposit is therefore contemporaneous with that of the Iowan drift or younger.

Recent Series

ALLUVIUM.

The alluvial deposits of Iowa county are relatively extensive. It is estimated that one-sixth of the entire surface of the county

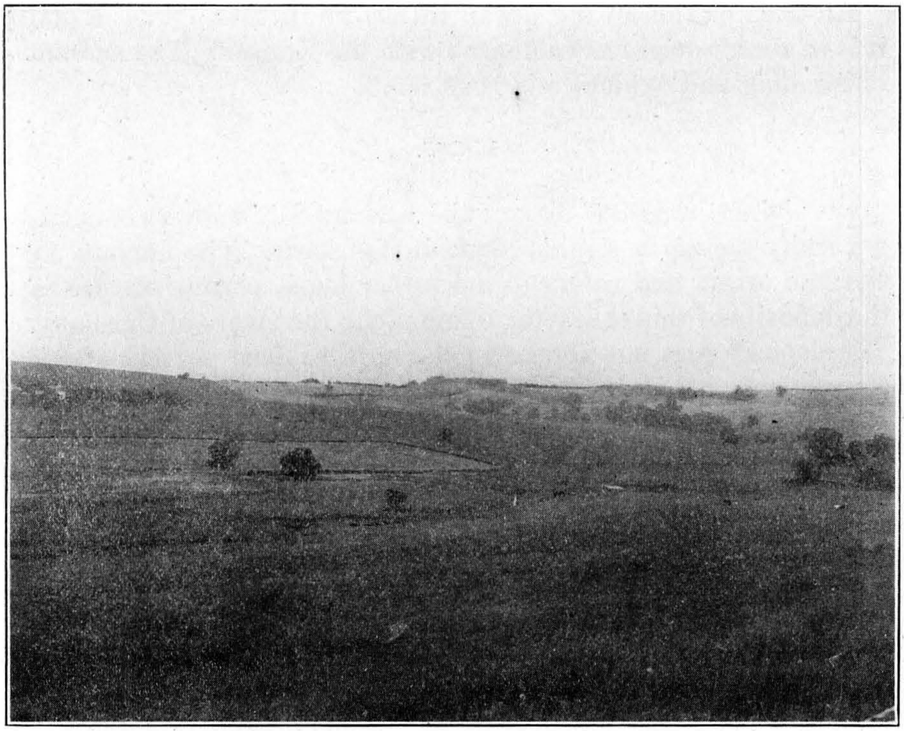


Figure 14. An alluvial valley typical of Iowa county streams. In section 1, Township 81, Range 11.

consists of bottom lands. All the principal streams meander through alluvial plains from a quarter of a mile to three miles in width. The alluvial plain of the Iowa river alone comprises an estimated area of sixty square miles. These bottom lands are for the most part rich sandy loams, and immense crops are raised upon them. Occasional inundations are destructive, but farmers believe that the total rewards of the cultivation of these lands are greater than of equal areas of uplands.

The Amana Society, one of the most interesting and successful communal organizations known, owns the bottom lands along the Iowa river in Amana township, and with its careful system of farming, raises fine crops of the various grains and grasses.

PREGLACIAL SURFACE

Although the almost universal presence of the thick mantle of drift and the lack of surface exposures of the indurated rocks in Iowa county render it difficult to restore the ancient surface upon which the drift was laid, nevertheless much may be inferred from well records. If these were sufficient in number and accuracy the whole surface could be restored with considerable detail. Unfortunately for this purpose, the number of wells that reach the bed rock is small, and drillers are not always careful to keep accurate records of those that do.

It has been shown by Mosnat that the Belle Plaine Artesian basin extends into Iowa county in a southeasterly direction as far as a line drawn from Marengo through Ladora to Victor. The hypothesis of a preglacial river valley running in a northwest-southeast direction through Tama, southwest Benton, and northwest Iowa counties has been generally accepted in explanation of the phenomena of the Belle Plaine basin. As the basin is some six miles in width and of considerable depth, the hypothetical river must have been at work during a long period of time cutting its gorge deeply into the sediments that had been laid down in the Carboniferous seas and subsequently elevated into a land surface; and in wearing down its slopes and widening its valley.

It was over such a surface as this that the first ice sheet deployed at the beginning of the Ice Age—a surface deeply eroded and dissected with stream valleys. The Nebraskan ice sheet was not able entirely to fill up these ancient valleys nor to reduce the elevations, although such was the tendency. When the ice retreated at the end of the Nebraskan phase, this broad valley still existed, although partly filled with glacial debris. It again became the channel of a river and the Aftonian sands and gravels were laid. The Kansan ice sheet again overspread the region and completely filled the valleys and leveled the whole face of the country.

There is evidence of the extension of this broad depression southeastward through Iowa county, although the artesian conditions that obtain in the Belle Plaine area do not exist. The thickness of the drift increases in a general way from the northeast and the southwest toward a line running in a northwest-southeast direction through the county. A section from Homestead to North English passing through Williamsburg and Parnell, would cut this basin almost at right angles. At North English the drill strikes rock at 599 feet above tide. At Parnell rock is found at 504 feet above tide, which is 95 feet lower than at North English, while the shale at Williamsburg is found at 400 feet above tide, or 234 feet lower than at North English. At Homestead the shales are found at 489 above tide, or 124 feet higher than at Williamsburg.

In Washington county Calvin calls attention to the buried river channel at the town of Washington, and Bain finds evidence of its extension into the northwestern part of the same county. The latter author suggests a connection of this with a buried channel in Poweshiek county at Deep River. It is probable that these are all parts of the ancient drainage system of the region, and that the principal waterway was the one occupying the valley traced from a few miles north of Vining in Tama county through Benton and Iowa counties and on through Washington county to its outlet.

ECONOMIC PRODUCTS

Soils

Loess clay or upland clay soil covers the larger part of the county. Its natural characteristics as a finely comminuted, complex mixture of mineral ingredients, possessing porosity, render it almost an ideal basis for a soil. Under the most favorable conditions, it can scarcely be excelled, and great crops of cereals are raised upon it. During the long period after this material was spread, a rank vegetation had possession of it, adding year by year and century after century a constantly increasing residuum of humus, gradually changing the superficial layer from a yellow to an ashen color, and assisting in preserving and increasing its life and porosity. These more level portions were the prairies and included the interfluvial divides. Year after year, century after century, the deep rooting perennials of the prairies brought from the deeper soils the plant food, and returned it in part to the surface either in their partially decayed tissues or in the ash left by the annual prairie fires. The atmosphere contributed its share to the enrichment of the soil, the rains and snows carrying down ammonia and nitric acid. Micro-organisms, the nitrifying bacteria, and root bacteria, increasing with the growth of vegetation, elaborated in the soil more and more food in the most available form and in turn stimulated still further the growth of a rich vegetation. Thus, through centuries of time, the agencies of nature were elaborating and preparing the soils of Iowa county to produce immense crops under the culture of civilized man. The known processes by which soils are naturally enriched and made ready for large production should teach valuable lessons of soil management. The slow work of the centuries may by improper farming be destroyed and the soils rendered almost useless. The humus will soon be used up, the stored up food consumed in the gross-feeding cereal crops, the life and porosity of the soils lost under the leaching and washing unavoidable in cultural methods. These lessons have been learned too often by sad experience, and almost too late to apply the remedy. It was thought that these prairie soils were inexhaustible, but this is not true. The same natural agencies that have so generously operated in the ages past to prepare these soils are still here as active as ever, ready to co-operate with intelligence in rendering them still richer and more productive. The root-bacteria which grow upon the roots of the clovers, field peas, and other leguminous plants, will do their work in storing up food in the soil, and in producing an ideal mass of vegetable tissue to be returned to the soil as humus, if only given an opportunity. Fortunately these clay soils of the uplands of Iowa county are peculiarly adapted to the production of immense crops of clover. Valuable as this is as a forage crop, it will often pay many times better to return the whole crop to the soil, thus adding the necessary humus and vegetable acids, restoring the porosity necessary to the proper aeration of the soil, and proper action of capillarity upon the water in the soil.

The ability in a soil to stand well either excess of moisture or the lack of it, is dependent upon the presence in the soil of the qualities given by decaying organic matter. If the same thing is accomplished by the return of humus to the soil through stable manures, another set of bacteria is ready to assist in its proper elaboration into plant food. There is no reason why, by proper management, these soils may not be rendered increasingly responsive to culture and more and more productive.

Figure 15. Results of a common system of farming loess hills. Near the north line of section 4, Township 81, Range 11 west.

The loess soils in the more hilly regions along the streams furnish a problem of their own. Originally they were all wooded, and much of this area is still covered with trees and should be left so. The labor of farming these steep hillsides is excessive, and the returns are comparatively meager. In many places the soil is naturally poor from excess of sand. In other places the soil is naturally rich, but it washes badly, and the manure that is spread upon it is rapidly carried down the slopes and lost.

Where there is not excess of sand, the soil bakes, showing its loss of life and porosity. If such lands must be cultivated, their constant renewal by stable manures and especially by clover is absolutely essential to success.

The soil of the Iowan drift is in many ways in contrast with the loess-Kansan. The land is level or gently rolling. The soil itself is generally a rich black loam, and very productive.

The importance of the large body of alluvial soil in Iowa county has already been remarked. Much of this soil is exceedingly rich, warm and well drained. It seems as nearly inexhaustible as possible, producing year after year immense crops of corn, oats, and timothy. The rich agricultural lands possessed by the Amana Society are of this class. The occasional addition of silt and other debris to these bottom lands is an added source of fertility.

Water Supply

The water supply of Iowa county is from (a) the rivers, streams and springs; (b) ordinary drift wells; (c) ordinary wells drilled into bed rock; (d) artesian wells in drift; and (e) deep artesian wells. The region is well supplied with streams which furnish to the lands bordering them a fairly constant supply of good water. In times of extreme drouth, however, only the larger streams can be depended upon.

The principal source of water supply throughout the larger part of the county is the drift wells. Nearly everywhere the Kansan drift contains layers of sand and gravel which are reservoirs for an abundance of water of the best quality. Ordinary wells in rock are chiefly confined to the southwestern parts of the county, where an abundance of water is obtained in lime or sand rock at a depth of 150 to 250 feet. Throughout those parts of the county where the Pleistocene deposits are underlain by shale, the wells are in the drift. The shales are non-water-bearing, and rarely are they penetrated for the supply that might be found in the Devonian limestones beneath. At Williamsburg and Parnell are wells furnishing excellent water from Devonian limestone. As already noted, the northwestern part of the county as far south as Ladora forms a part of the Belle Plaine Artesian Area.

The Aftonian gravels form the aquifer at a depth of fifty to two hundred feet, varying with the location with reference to the axis of the basin. The water from these wells is strongly mineralized and corrosive. It is excellent for stock, but useless for drinking and cooking.

The town of Marengo has three artesian wells, one in the park, one in the public school grounds, and one at the Lovell House. The aquifer for these wells is the Devonian limestones. Homestead and Amana have deep artesian wells, strongly mineral.

Lime

In the early years of the colonists at Amana, they burned their lime for local use from the Kinderhook limestone exposed at their principal village. It proved of excellent quality as to durability and strength, but was dark colored. Later other limes were shipped in and at the present time, no lime is burned in the county.

Building Stone

The outlier of the Des Moines sandstone exposed in the bluffs along the Iowa river in Amana township has been quarried at several places, notably west of West Amana, east of Hohe Amana, and near East Amana. The largest amount has been taken from the quarry at West Amana. Many of the buildings of the villagers belonging to the Amana Society are of this stone, and occasionally it has been used in other places in the county. It is quite soft when taken from the quarry, but hardens on exposure into a fairly durable building stone, especially when used above ground. It tends to disintegrate when used below ground. Its effect in buildings is not particularly pleasing, owing to the discoloration of the iron. Bowlders of the Iowan drift have been used to some extent for building purposes, but they are comparatively scarce, even in parts of the county overspread with Iowan till.

Clay Products

Iowa county has an inexhaustible supply of the best material for brick, tile, and crockery. The alluvial and upland loessial clays are unexcelled for this purpose. Several brick and tile plants have been established in the county and for the most part are doing a good business.

Mr. J. W. Wagner has a well equipped plant two miles south of Marengo. He employs from fifteen to twenty men. He has four kilns with a total capacity of 340,000 bricks. The upper five feet of the loess works best, being more plastic. The unleached deeper portion is "short". A mixture of the surface clay with the deeper layers increases plasticity. Mr. Wagner proposes to install a machine for removing the pebbles from bowlder clay, and mixing this with the loess clay.

Lewis and Lewis, located two miles southeast of Williamsburg, have an excellent equipment for the manufacture of brick and tile. Steam is used in drying, thus extending the working year. The clay used is a secondary deposit from the Kansan till and loess. This clay possesses high plasticity, and would be improved with an admixture of sand, if such were available. The product is of excellent quality. Practically the whole output is used locally. Smith Brothers of North English have four kilns and run an extensive business, making brick and tile. H. A. Cheney of Millersburg has one kiln in operation making brick.

Coal

With the exception of the outlier of the Des Moines sandstone along the Iowa river in Amana township, all the rocks that lie beneath the surface in Iowa county are older than the Coal Measures. No rocks older than the Coal Measures have ever been known to yield workable coal. Iowa county lies entirely beyond the region of the Coal Measures and there is no evidence that coal exists anywhere in the deposits of the county.

Meteorites

Although not a purely geological subject, it is proper to refer to the Amana meteorite of 1875. This wonderful meteorite was seen, in its fall, over an area reaching from St. Louis to St. Paul, and from Chicago to Omaha, and produced a profound sensation by its unusual brilliancy. Before reaching the earth it parted into two bodies, with loud detonation. The larger of the two bodies passed on over Iowa county and was believed to have fallen in Benton county, but was never found. The smaller portion fell in fragments over the region south of the Amana villages, townships 80-81 North, ranges IX-X West. The meteorites collected from this field weigh, together, according to Hinrichs, from whose account the facts are taken, nearly a quarter of a ton, and constitute one of the most remarkable collections of cosmical matter in the world. These meteorites have been generally distributed through the great museums of this country and Europe.

ACKNOWLEDGMENTS

The writer would acknowledge with thankfulness the aid received in his work in Iowa county from many of its citizens. A number of well drillers, including Mr. M. B. Wright of Marengo, Thomas Gittens of Williamsburg, and F. L. Pounds of Millersburg, were painstaking and obliging in giving information concerning the wells of the county. Dr. Charles F. Noe of Amana, Dr. William Moershal of Homestead and others of the Amana Society gave valuable and much appreciated assistance. Mr. Conrad Schadt, the druggist of Amana, compiled the list of plants published in connection with this report. And especially Dr. Calvin, Director of the Survey, has been ready with help and suggestions at all times. The photographs are by Dr. Calvin.

FLORA OF IOWA COUNTY

A list of plants found growing wild in Iowa county, Iowa; by *William Moerschal and Conrad Schadt, pharmacists, Amana, Iowa. Compiled by C. Schadt.

Orders or families and nomenclature are based upon Gray's Manual, 5th edition.

Ranunculaceae.	Crowfoot Family.
Clematis Viorna	Leather-flower
Clematis Virginiana	Common Virgins' Bower
Anemone Pennsylvanica	Pennsylvanian Anemone
Anemone nemorosa	Wind-flower. Wood Anemone
Hepatica triloba	Round-lobed Hepatica. Liver-leaf

*Deceased.

Hepatica acutiloba	Sharp-lobed Hepatica
Thalictrum anemonoides	Rue-anemone
Thalictrum purpurascens	Purplish Meadow-rue
Ranunculus abortivus	Small flowered Crowfoot
Ranunculus fascicularis	Early Crowfoot
Ranunculus repens	Creeping Crowfoot
Ranunculus acris	Buttercups
Caltha palustris	Marsh Marigold
Aquilegia Canadensis	Wild Columbine
Menispermaceae.	**Moonseed Family.**
Menispermum Canadense	Canadian Moonseed
Berberidaceae.	**Barberry Family.**
Caulophyllum thalictroides	Blue Cohosh
Podophyllum peltatum	May-apple
Nympheaceae.	**Water-Lily Family.**
Nelumbium luteum	Yellow Nelumbo
Papaveraceae.	**Poppy Family.**
Chelidonium majus	Celandine
Sanguinaria Canadensis	Blood-root
Fumariaceae.	**Fumitory Family.**
Dicentra cucullaria	Dutchman's Breeches
Cruciferae.	**Mustard Family.**
Nasturtium palustre	Marsh Cress
Nasturtium Armoracia (Escaped from gardens)	Horseradish
Brassica Sinapistrum	Charlock
Capsella Bursa-pastoris	Shepherd's Purse
Thlaspi arvense	Field Pennycress
Capparidaceae.	**Caper Family.**
Cleome pungens	Cleome
Violaceae.	**Violet Family.**
Viola cucullata	Common Blue Violet
Viola pubescens	Downy Yellow Violet
Hypericaceae.	**St. John's-Wort Family.**
Hypericum pyramidatum	Great St. John's-wort

Caryophyllaceae.	**Pink Family.**
Stellaria media	Common Chickweed
Portulacaceae.	**Purslane Family.**
Portulaca oleracea	Common Purslane
Claytonia Virginica	Narrow-leaved Spring Beauty
Malvaceae.	**Mallow Family.**
Abutilon Avicennae	Velvet Leaf Indian Mallow
Hibiscus militaris	Halbert-leaved Rose Mallow
Tiliaceae.	**Linden Family.**
Tilia Americana	Basswood. Whitewood
Geraniaceae.	**Geranium Family.**
Geranium maculatum	Wild Cranesbill
Impatiens fulva	Spotted Touch-me-not
Oxalis violacea	Violet Wood-sorrel
Oxalis stricta	Yellow Wood-sorrel
Oxalis corniculata	Yellow Wood-sorrel
Rutaceae.	**Rue Family.**
Zanthoxylum Americanum	Northern Prickly Ash
Anacardiaceae.	**Cashew Family.**
Rhus glabra	Smooth Sumach
Rhus Toxicodendron	Poison Ivy, Poison Oak
Rhus radicans	Climbing Ivy. Poison Ivy
Vitaceae.	**Vine Family.**
Vitis cordifolia	Winter or Frost Grape
Ampelopsis quinquefolia	American Ivy. Virginia Creeper
Rhamnaceae.	**Buckthorn Family.**
Ceanothus Americanus	New Jersey Tea
Celastraceae.	**Staff-Tree Family.**
Celastrus scandens	Wax-work. Climbing Bitter-sweet
Euonymus atropurpureus	Burning-bush. Wahoo

Sapindaceae.	Soapberry Family.
Acer saccharinum (rare)	Sugar or Rock Maple
Acer dasycarpum	Silver Maple
Acer rubrum	Red or Swamp Maple
Negundo aceroides	Box Elder. Ash-leaved Maple
Polygalaceae.	Milkwort Family.
Polygala sanguinea	Milkwort
Polygala Senega	Seneca Snakeroot
Leguminosae.	Pulse Family.
Trifolium arvense	Rabbit-foot or Stone Clover
Trifolium pratense	Red Clover
Trifolium repens	White Clover
Psoralea melilotoides	Psoralea
Petalostemon violaceus	Purple Prairie Clover
Petalostemon candidus	White Prairie Clover
Amorpha fruticosa	False Indigo
Amorpha canescens	Lead Plant
Robinia pseudacacia	False Acacia. Common Locust Tree
Astragalus canadensis	Milk Vetch
Desmodium acuminatum	Tick Trefoil
Desmodium humifusum	Tick Trefoil
Lathyrus pratensis	Vetchling. Everlasting Pea
Apios tuberosa	Ground Nut
Phaseolus diversifolius	Wild Bean
Baptisia leucantha	White False Indigo
Baptisia leucophaea	Yellow False Indigo
Cassia Marilandica	Wild Senna
Gleditschia triacanthos	Honey Locust. Three-thorned Acacia
Rosaceae.	Rose Family.
Prunus Americana	Wild Yellow or Red Plum
Prunus Pennsylvanica	Wild Red Cherry
Prunus Virginiana	Choke Cherry
Prunus serotina	Wild Black Cherry
Spirea salicifolia	Common Meadow-sweet
Spirea lobata	Queen of the Prairie

Geum album	Avens
Potentilla Norvegica	Five-finger
Fragaria vesca	Wild Strawberry
Rubus villosus	Common or High Blackberry
Rubus Canadensis	Low Blackberry. Dewberry
Rosa blanda	Early Wild Rose
Rosa lucida	Dwarf Wild Rose
Crataegus coccinea	Scarlet-fruited Thorn
Crataegus oxyacantha	English Hawthorn
Crataegus tomentosa	Black or Pear Thorn
Pyrus coronaria	American Crab Apple
Saxifragaceae.	**Saxifrage Family.**
Heuchera hispida	Alum Root
Crassulaceae.	**Orpine Family.**
Penthorum sedoides	Ditch Stone-crop
Sedum acre	Mossy Stone-crop
Onagraceae.	**Evening Primrose Family.**
Oenothera biennis	Common Evening Primrose
Lythraceae.	**Loosestrife Family.**
Lythrum alatum	Loosestrife
Cucurbitaceae.	**Gourd Family.**
Echinocystis lobata	Wild Balsam-apple
Umbelliferae.	**Parsley Family.**
Sanicula Canadensis	Black Snakeroot
Eryngium yuccaefolium	Button Snakeroot
Thaspium aureum	Meadow Parsnip
Cryptotaenia Canadensis	Honewort
Osmorhiza longistylis	Smoother Sweet Cicely
Eulophus Americanus	Eulophus
Araliaceae.	**Ginseng Family.**
Aralia racemosa	Spikenard
Aralia nudicaulis	Wild Sarsaparilla
Aralia quinquefolia (very rare)	Ginseng

Cornaceae.	Dogwood Family.
Cornus sericea	Silky Cornel. Killikinnik
Cornus asperifolia	Rough-leaved Dogwood
Caprifoliaceae.	Honeysuckle Family.
Lonicera sempervirens	Trumpet Honeysuckle
Triosteum perfoliatum	Fever-wort. Horse Gentian
Sambucus Canadensis	Common Elder
Viburnum Lentago	Sheepberry
Viburnum prunifolium	Black Haw
Viburnum Opulus	Cranberry Tree
Rubiaceae.	Madder Family.
Galium Aparine	Cleavers. Goose Grass
Galium triflorum	Sweet-scented Bedstraw
Cephalanthus occidentalis (rare)	Button-bush
Compositae.	Composite Family.
Liatris scariosa	Blazing Star. Button Snake-root
Liatris spicata	Blazing Star. Button Snake-root
Liatris pycnostachya	Blazing Star. Button Snake-root
Liatris paniculata	Blazing Star. Button Snake-root
Kuhnia eupatoroides	Kuhnia
Eupatorium purpureum	Joe-Pye Weed
Eupatorium perfoliatum	Thoroughwort. Boneset
Eupatorium ageratoides	White Snakeroot
Tussilago farfara (Escaped from gardens)	Coltsfoot
Sericocarpus tortifolius	White-topped Aster
Aster dumosus	Aster
Aster multiflorus	Aster
Aster Novae-Angliae	Aster
Aster sagittifolius	Aster
Aster ericoides	
Erigeron Canadense	Horse-weed. Button-weed

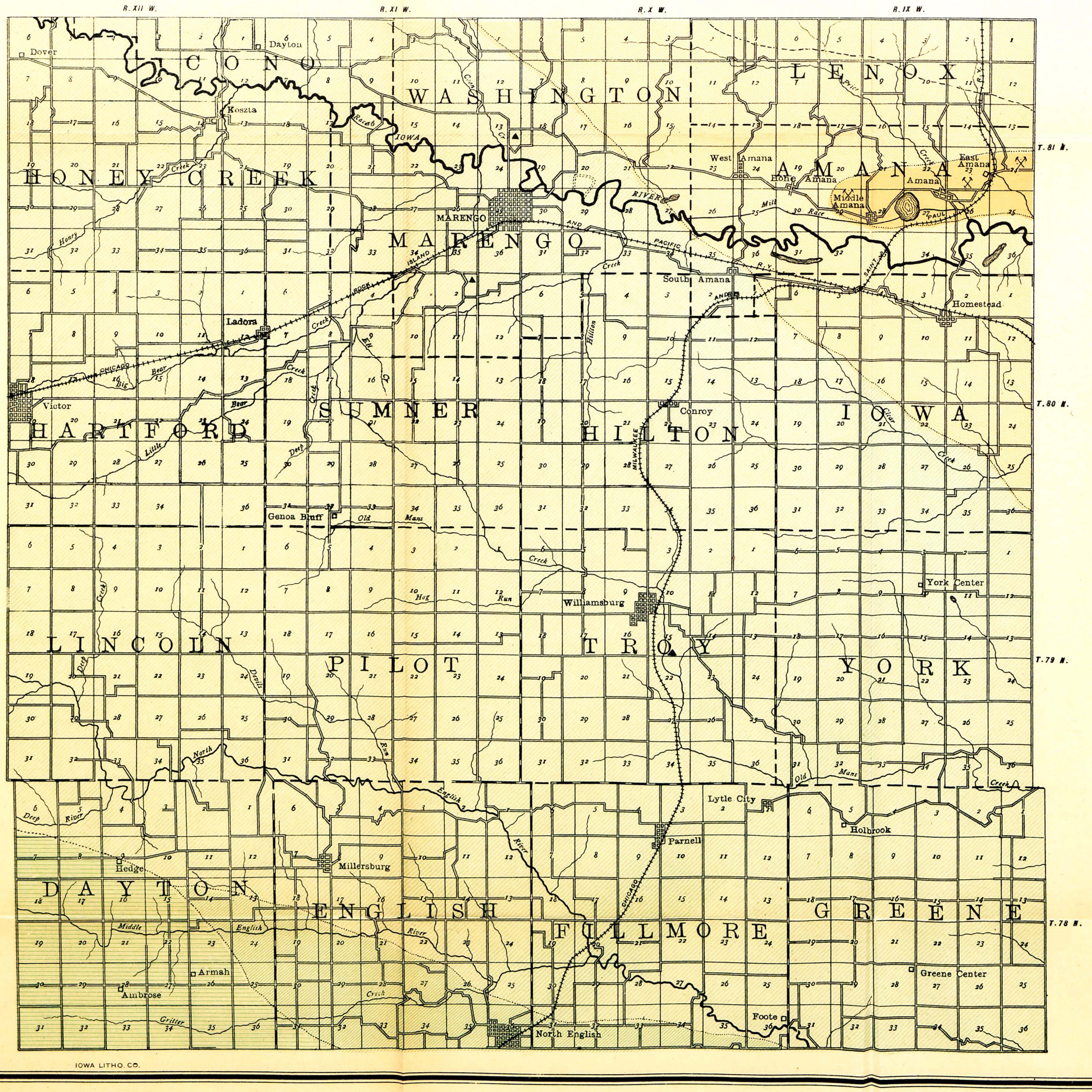
Erigeron philadelphicum	Common Fleabane
Boltonia glastifolia	Boltonia
Solidago Missouriensis	Golden-rod
Solidago rigida	Golden-rod
Inula Helenium (Escaped from gardens)	Elecampane
Silphium laciniatum	Compass-plant
Silphium perfoliatum	Cup-plant
Silphium integrifolium	Rosin-plant
Parthenium integrifolium	Parthenium
Ambrosia trifida	Great Ragweed
Ambrosia artemisiaefolia	Roman Wormwood
Xanthium strumarium	Common Cocklebur
Heliopsis laevis	Ox-eye
Echinacea purpurea	Purple Cone-flower
Rudbeckia hirta	Cone-flower
Rudbeckia triloba	Cone-flower
Lepachys pinnata	Cone-flower
Helianthus annuus	Common Sunflower
Helianthus grosse-serratus	Sunflower
Helianthus laetiflorus	Sunflower
Coreopsis tripteris	Tickseed
Bidens frondosa	Common Beggar-ticks
Bidens connata	Swamp Beggar-ticks
Dysodia chrysanthemoides	Fetid Marigold
Helenium autumnale	Sneeze-weed
Maruta Cotula	Common May-weed
Achillea millefolia	Milfoil. Common Yarrow
Leucanthemum vulgare	Ox-eye or White Daisy
Tanacetum vulgare (Escaped from gardens)	Common Tansy
Artemisia Ludoviciana	Western Mugwort
Antennaria plantaginifolia	Plaintain-leaved Everlasting
Cacalia tuberosa	Tuberous Indian Plantain
Cacalia atriplicifolia	Pale Indian Plantain
Senecio aureus	Golden Ragwort
Cirsium discolor	Common or Plumed Thistle
Lappa officinalis	Common Burdock

Cichorium Intybus	Succory or Cichory
Hieracium venosum	Rattlesnake-weed
Nabalus asper	Rattlesnake-root
Nabalus albus	White Lettuce
Taraxacum dens-leonis	Common Dandelion
Lactuca Canadensis	Wild Lettuce
Sonchus asper	Spiny-leaved Sow-thistle
Sonchus oleraceus	Common Sow-thistle
Lobeliaceae.	**Lobelia Family.**
Lobelia cardinalis	Cardinal-flower
Lobelia syphilitica	Great Lobelia
Lobelia inflata	Indian Tobacco
Campanulaceae.	**Bellflower Family.**
Campanula rotundifolia	Harebell
Campanula Americana	Tall Bellflower
Specularia perfoliata	Venus's Looking-glass
Ericaceae.	**Heath Family.**
Pyrola elliptica	Shin-leaf
Monotropa uniflora (rare)	Indian Pipe
Plantaginaceae.	Plantain Family
Plantago major	Common Plantain
Plantago lanceolata (Escaped from gardens)	Ribgrass. English Plantain
Primulaceae.	**Primrose Family.**
Dodecatheon Meadia	American Cowslip. Shooting Star
Bignoniaceae.	Bignonia Family.
Tecoma radicans (cultivated)	Trumpet Creeper
Catalpa (cultivated)	Catalpa
Scrophulariaceae.	Figwort Family.
Verbascum Thapsus	Common Mullein
Scrophularia nodosa	Figwort
Chelone glabra	Turtle Head. Balmony
Pentstemon digitalis	Beard's-tongue. Pentstemon

Veronica Virginica	Culver's Physic
Veronica peregrina	Neckweed. Purslane. Speedwell
Gerardia purpurea	Purple Gerardia
Gerardia tenuifolia	Slender Gerardia
Castilleia coccinea	Scarlet Painted-cup
Pedicularis Canadensis	Common Lousewort
Melampyrum Americanum	Cow-wheat
Ilysanthes gratioloides	False Pimpernell
Verbenaceae.	Vervain Family.
Verbena hastata	Blue Vervain
Verbena urticaefolia	Nettle-leaved or White Vervain
Verbena bracteosa	Prostrate Vervain
Phryma leptostachya	Lopseed
Labiatae.	Mint Family.
Mentha viridis	Spearmint
Mentha piperita	Peppermint
Lycopus Virginicus	Bugle-weed
Pycnanthemum lirifolium	Mountain Mint
Pycnanthemum lanceolatum	Mountain Mint
Monarda fistulosa	Wild Bergamot
Lophantus nepetoides	Giant Hyssop
Nepeta Cataria	Catnip
Brunella vulgaris	Common Self-heal or Heal-all
Scutellaria lateriflora	Mad-dog Skullcap
Stachys palustris	Hedge-nettle
Lamium amplexicaule	Dead-nettle
Leonurus Cardiaca	Common Motherwort
Borraginaceae.	Borage Family.
Lithospermum hirtum	Hairy Puccoon
Mertensia Virginica	Virginian Cowslip or Lungwort
Echinospermum Lappula	Common Stickweed
Hydrophyllaceae.	Waterleaf Family.
Hydrophyllum Virginicum	Waterleaf
Ellisia nyctelea	Ellisia

Polemoniaceae.	**Polemonium Family.**
Polemonium reptans	Polemonium
Phlox pilosa	Wild Phlox
Convolvulaceae.	**Convolvulus Family.**
Ipomoea purpurea	Common Morning Glory
Calystegia sepium	Hedge Bindweed
Cuscuta glomerata	Dodder
Solanaceae.	**Nightshade Family.**
Solanum nigrum	Common Nightshade
Physalis pubescens	Ground Cherry
Datura Stramonium	Common Stramonium. Thorn Apple
Gentianaceae.	**Gentian Family.**
Gentiana Andrewsii	Closed Gentian
Gentiana Saponaria	Soapwort Gentian
Gentiana puberula	Gentian
Apocynaceae.	**Dogbane Family.**
Apocynum androsaemifolium	Spreading Dogbane
Apocynum cannabium	Indian Hemp
Asclepiadaceae.	**Milkweed Family.**
Asclepias Cornuti	Common Milkweed
Asclepias incarnata	Swamp Milkweed
Asclepias tuberosa	Butterfly-weed
Acerates longifolia	Green Milkweed
Oleaceae.	**Olive Family.**
Fraxinus Americana	White Ash
Fraxinus sambucifolia	Black or Water Ash
Aristolochiaceae.	**Birthwort Family.**
Asarum Canadense	Wild Ginger. Asarabacca
Phytolaccaceae.	**Pokeweed Family.**
Phytolacca decandra	Common Poke. Garget
Chenopodiaceae.	**Goosefoot Family.**
Chenopodium album	Lambs-quarters. Pigweed
Amaranthaceae.	**Amaranth Family.**
Amaranthus retroflexus	Pigweed. Green Amaranth

Polygonaceae.	**Buckwheat Family.**
Polygonum Virginianum	
Polygonum Convolvulus	Black Bindweed
Polygonum Hydropiper	Common Smartweed
Polygonum aviculare	Knot Grass. Doorweed
Polygonum dumetorum	Climbing False Buckwheat
Fagopyrum esculentum	Common Buckwheat
Rumex orbiculatus	Great Water-dock
Rumex Brittanica	Pale Dock
Rumex verticillatus	Swamp Dock
Rumex crispus	Curled Dock
Euphorbiaceae.	**Spurge Family.**
Euphorbia maculata	Spurge
Euphorbia corollata	Spurge
Acalypha Virginica	Three-seeded Mercury
Urticaceae.	**Nettle Family.**
Ulmus fulva	Slippery or Red Elm
Ulmus Americana	American or White Elm
Celtis occidentalis	Hackberry
Morus rubra	Red Mulberry
Laportea Canadensis	Wood-nettle
Cannabis sativa	Common Hemp
Humulus Lupulus	Common Hop
Platanaceae.	**Plane-Tree Family.**
Platanus occidentalis	American Plane. Sycamore
Juglandaceae.	**Walnut Family.**
Juglans nigra	Black Walnut
Juglans cinerea	Butternut
Carya alba	Shellbark Hickory
Carya amara	Bitternut or Swamp Hickory
Cupuliferae.	**Oak Family.**
Quercus alba	White Oak
Quercus macrocarpa	Bur Oak
Quercus rubra	Red Oak
Corylus Americana	Hazel-nut



IOWA GEOLOGICAL SURVEY

GEOLOGICAL MAP OF IOWA COUNTY, IOWA.

BY

S. W. STOOKEY

1910

Scale $\frac{1}{125000}$

1 ½ 0 1 2 3 4 5 Miles.

1 ½ 0 1 2 3 4 5 Kilometers

LEGEND

GEOLOGICAL FORMATIONS

PENNSYLVANIAN
DES MOINES

MISSISSIPPIAN
SAINT LOUIS
OSAGE
KINDERHOOK

MIDDLE DEVONIAN
CEDAR VALLEY

THE MARGIN BETWEEN THE IOWAN AND THE KANSAN DRIFTS IS INDICATED BY THE BROKEN LINE ACROSS LENOX TOWNSHIP.

INDUSTRIES

QUARRIES

CLAY WORKS

Betulaceae.	**Birch Family.**
Betula papyracea	Paper or Canoe-birch
Alnus incana	Speckled Alder
Salicaceae.	**Willow Family.**
Salix humilis	Prairie Willow
Salix cordata	Heart-leaved Willow
Salix nigra	Black Willow
Populus monilifera	Cottonwood
Populus dilatata (Cultivated, but at present almost wholly died out.)	Lombardy Poplar
Coniferae (all cultivated).	**Pine Family.**
Pinus strobus	White Pine
Pinus sylvestris	Scotch Pine
Pinus Austriaca	Austrian Pine
Abies excelsa	Norway Spruce
Abies balsamea	Common Balsam Fir
Larix Europaea	European Larch
Thuya occidentalis	Arbor Vitae or White Cedar
Juniperus Virginiana	Red Cedar
Araceae.	**Arum Family.**
Arisaema triphyllum	Indian Turnip
Arisaema Dracontium	Dragon Arum. Green Dragon
Symplocarpus foetidus	Skunk Cabbage
Lemnaceae.	**Duckweed Family.**
Lemna (species not defined)	Duckweed
Typhaceae.	**Cat-Tail Family.**
Typha latifolia	Common Cat-tail
Sparganium eurycarpum	Bur-reed
Alismaceae.	**Water-Plantain Family.**
Alisma Plantago	Water-plantain
Sagittaria variabilis	Common Arrow-head
Sagittaria heterophylla	Arrow-head
Orchidaceae.	**Orchis Family.**
Orchis spectabilis (rare)	Showy Orchis
Habenaria leucophaea	Rein-orchis
Cypripedium spectabile	Showy Lady's Slipper

Amaryllidaceae.	**Amaryllis Family.**
Hypoxys erecta	Star-grass
Iridaceae.	**Iris Family.**
Iris versicolor	Common Blue Flag
Sisyrinchium Bermudiana	Blue-eyed Grass
Dioscoreaceae.	**Yam Family.**
Dioscorea villosa	Wild Yam-root
Smilaceae.	**Smilax Family.**
Smilax hispida	Greenbriar
Smilax herbacea	Carrion-flower
Liliaceae.	**Lily Family.**
Trillium nivale	Dwarf White Lily
Zygadenus glaberrimus	Zygadene
Uvularia grandiflora	Bellwort
Smilacina racemosa	False Spikenard
Smilacina stellata	False Solomon's Seal
Smilacina bifolia	False Solomon's Seal
Polygonatum biflorum	Smaller Solomon's Seal
Polygonatum giganteum	Great Solomon's Seal
Asparagus officinalis (Escaped from gardens)	Garden Asparagus
Lilium Philadelphicum	Wild Orange-red Lily
Lilium Canadense	Wild Yellow Lily
Erythronium albidum	White Dog-tooth Violet
Pontederiaceae.	**Pickerel-weed Family.**
Pontederia cordata	Pickerel-weed
Commelynaceae.	**Spiderwort Family.**
Tradescantia Virginica	Common Spiderwort
Gramineae.	**Grass Family.**
Zizania aquatica	Indian Rice. Water Oats
Poa pratensis	Kentucky Bluegrass
Triticum repens	Couch or Quick-grass
Hordeum jubatum	Squirrel-tail Grass
Cenchrus tribuloides	Bur-grass
Polypodiaceae.	**True Ferns.**
Adianthum pedatum	Maidenhair