GEOLOGY OF GRUNDY COUNTY

BY

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INTRODUCTION

LOCATION AND AREA.

The name of this county was given in honor of Felix Grundy of Tennessee. Its territory was once a part of Benton and Buchanan counties successively. It contains approximately 504 square miles in fourteen townships. The counties immediately west of Grundy lie one township's width farther south than do the counties east of it and while Grundy's north line conforms wholly with that of the counties west, the eastern half of its south line is the same as that of the counties east, the other half conforms to that of the counties west, by which fact it suffers the lack of two townships that now constitute a part of Tama county. The civil townships correspond in boundaries with the congressional townships in every instance. Four counties intervene between it and the Mississippi river while Butler, Floyd and Mitchell are between it and the Minnesota line. Butler lies immediately north of it, Black Hawk and Tama adjacent to its east line, Tama and Marshall bound it upon the south and Hardin upon the west. It contains no large city, but it has several enterprising centers of trade activity along the railroads that cut its territory. Its reputation as an agricultural region is unsurpassed.

PREVIOUS GEOLOGICAL WORK.

Grundy county offers little inducement to the paleontologist or to the student of the indurated rocks. It is not surprising, therefore, that the record of geological observation is a brief one. Hall makes the first allusion.* He says the Burlington limestone "has been traced through the westerly part of Iowa, Tama and Grundy counties." The Paleozoic rock formations were well represented in New York and Pennsylvania where

*Hall: Geol. of Iowa, Vol. I, Part I, p. 93, 1858.

they were thoroughly studied by the earlier geologists and a careful system of stratigraphical notation was adopted which naturally became a standard for subsequent workers in other states. Conditions in Iowa and the Mississippi valley generally were so different from those in the east that the problem of correlation of the Iowa formations with this standard was a very difficult one, and a wide divergence of views arose as investigation proceeded, but out of it all there has been reached at last a satisfactory agreement in all major particulars, the result of which as far as Iowa is concerned may be seen in the Paleozoic portion of the geological section of Iowa as made by Professor Calvin and published in the Journal of Geology.*

At the time the above quoted statement was written the term Kinderhook was not in use, but the deposits now known under that name, along with some others now unhesitatingly referred by Calvin to the Devonian, were grouped as Chemung, as is evidenced by Hall's section at Burlington. The term Burlington no longer has geological significance except historically, but the limestone to which that name was applied and certain related strata have been grouped together under the designation Osage limestone. The extent of the Osage in Iowa does not warrant the inclusion within its range of Tama and Grundy counties, or indeed of Iowa county beyond a small portion of its southeastern corner. The Kinderhook of today occupies by far the larger part of the territory of Iowa attributed to the Mississippian series, and to it belong the very limited outcroppings of rock in Grundy county.

This county lies just within the western border of the area included by McGee in his Pleistocene History of Northeastern Iowa, but with a single minor exception, only general allusions are made to it in discussing the subjects, topography, streams and drift. The exposure of Kinderhook limestone at Conrad is mentioned by him as it has been at different times by Keyes,† Beyer‡ and others.

*Calvin: Jour. of Geol., Vol. IV, p. 572. See also Jour. of Geol., Vol. XIV, 1906, and Iowa Geological Survey, Vol. XVII, pp. 193-200.

†Keyes: Geological formations of Iowa, Iowa Geol. Surv., Vol. I, p. 58.

‡Beyer: Geol. Surv. of Iowa, Vol. X, p. 270, and Vol. XVII, p. 379.

PHYSIOGRAPHY

Topography

The surface of the county is that of an extended, elevated drift plain gently sloping northeast, southeast and south, but more abruptly to the southwest, the culminating point being near section 28, Shiloh township. The original drift surfaces have been very little modified, since the drainage is effected by small headwater streams of low gradient and consequently of slight erosive power. Considerable areas in the southwestern part of the county have been covered with loess, but, as usual, it has conformed to the eroded surface upon which it was deposited, and so has produced no other effect than slightly to increase the elevation.

The topography of the north tier of townships is unmistakably that of the Iowan drift, while in Felix, Clay, Washington and the greater part of Melrose and Palermo townships it is as unmistakably Kansan in all essential particulars. The intermediate territory is a neutral zone, or better perhaps, it partakes of the nature of both. The salient features of these two drift deposits become toned down as the distance from each distinct area increases. They blend in places and in other places the one gives way to the other somewhat. Upon the whole it may be said that the eastern half of this zone exhibits more of the Iowan characteristics, while the Kansan predominates in the western half.

In Felix and Clay townships especially the interstream areas are very flat, though in the western border, the short tributaries of the Iowa river in making their descent from the divide with high gradients have cut deep V-shaped valleys, giving more of the rugged Kansan aspect to the landscape, though there is little of the dendritic type developed in the streams.

If we except the slight exposures at and near Conrad and Beaman, there are no limestone escarpments along the streams, nor are there any other outcroppings of rock to introduce a little variety into the universally prevailing drift topography. There is no reason to believe that the underlying rock anywhere contributes to the topographic features of the county, the wells invariably reaching rock below the level of the bases of the elevations into which they have been sunk. Glacial deposits

alone account for whatever variation of level may be found anywhere in the county. In the northern half a very few superposed modified drift forms are to be noted. In sections 2, 11, 12 and 13, German township, and 7 and 8, Pleasant Valley township, a ridge of notable prominence runs through a gently undulating Iowan plain, rising in section 13 to a maximum of fifty or sixty feet above the general level. Its crest consists of a series of elongated, ellipsoidal hills with a trend of twenty to thirty degrees north of west and running not in line, but *en*

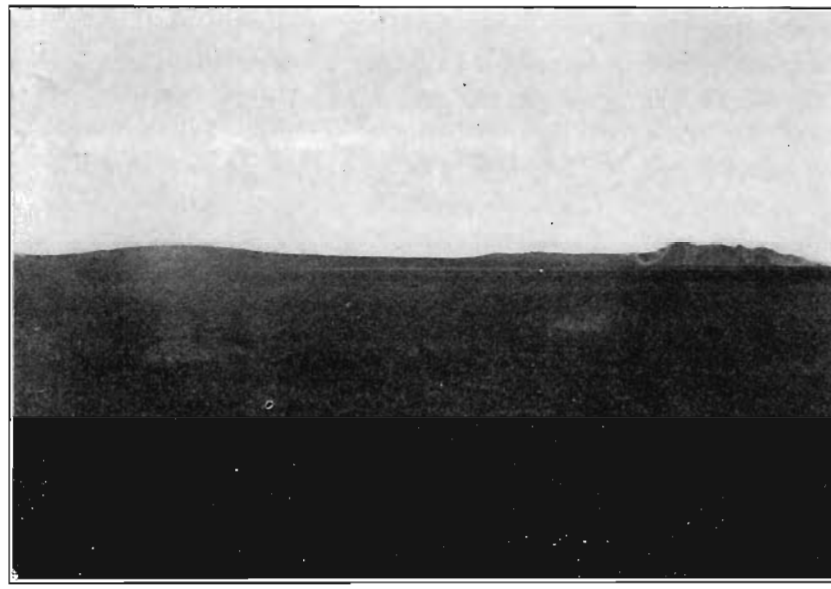

Figure 6. East end of the pahoid hills in sections 7 and 8, Pleasant Valley township. Seen from the road at west side of section 7, near the southwest corner.

echelon. A cut ten feet or more in depth in the road on the east line of section 11 exposes to that depth a fine gray loess slightly tinged with yellow.

These hills are in all essential particulars very much like a more extensive group of paha three or four miles north in Butler county. So far as the writer knows they are the most southwestern representatives of a type of glacial deposits not uncommon in the south half of the Iowan drift area. Free from bowlders, usually well tilled, and having soft, smooth contour lines, they supply a most pleasing variation in the somewhat monotonous landscape of the ordinary Iowan drift plain.

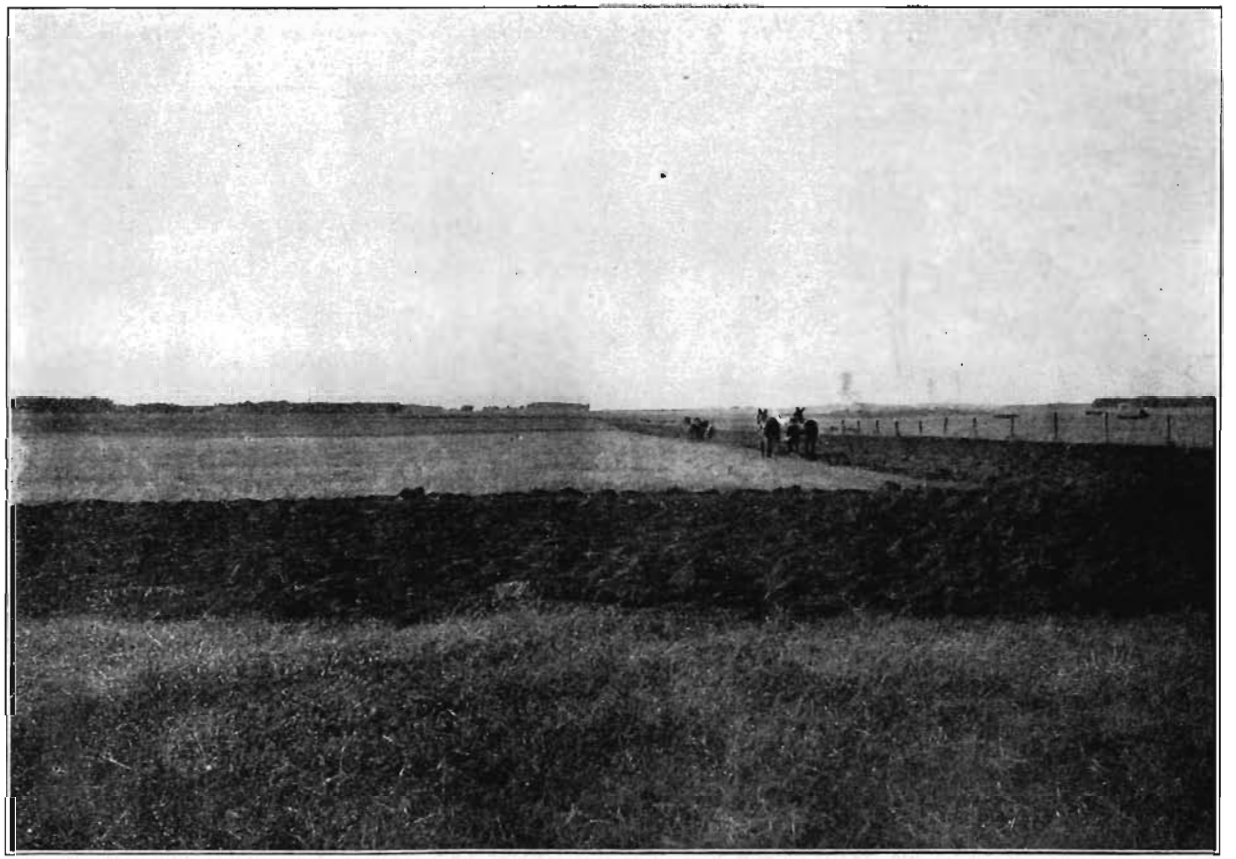

Plate IX. Flat-Kansan topography, Clay township, north of Beaman.

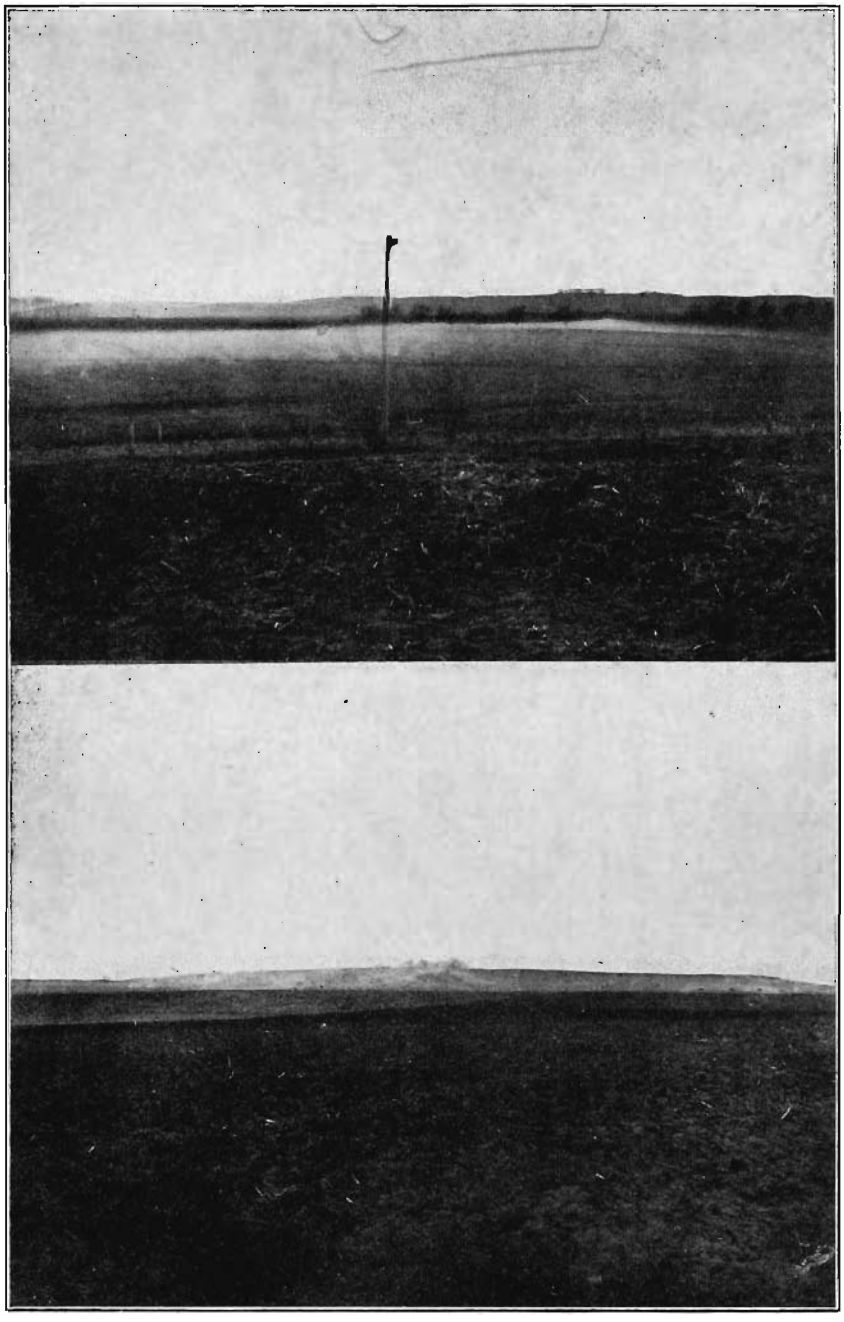

Plate X. Upper view—Pahoid hills in section 7, Pleasant Valley township. Seen from a point one mile to the north.

Lower view—The western paha, section 12, German township. View taken from road on south line section 12, near southeast corner of section.

The branches of Beaver creek in Pleasant Valley township approach each other in such a manner that their somewhat extensive valleys coalesce for unusual distances. The resultant broad valley is continued for a considerable distance beyond the points of juncture, so that a large part of the township consists of a rich alluvial valley of great beauty, readily suggesting the very appropriate name which it bears. The gathering of the water of the principal tributaries of Black Hawk creek in Black Hawk township has produced similar results there. Like conditions obtain along the North Black Hawk in the neighborhood of Dike.

Thus briefly, unless we descend to the most unimportant particulars, is told all that distinguishes topographically the area of an entire county, bringing it into sharpest contrast with the much dissected surface of the counties of the driftless area on the one hand and on the other with those where both glacial and erosive activities have combined to give striking and varied effects without stint. Foremost, perhaps, in agricultural importance, it stands unique, undoubtedly, among all the counties of eastern Iowa in the paucity of its geological details.

Comparatively few altitudes within the county have been computed, or at least are accessible. The following have been taken from Gannett's Dictionary of Altitudes:

TABLE OF ALTITUDES.

STATION.	FEET.	AUTHORITY.
Beaman	984	C. & N.-W. R. R.
Cleves	1070	C., R. I. & P. R. R.
Conrad	1010	C. & N.-W. R. R.
Grundy Center	976	C., R. I. & P. R. R.
Hicks	906	C. G. W. R. R.
Holland	995	C., R. I. & P. R. R.
Morrison	947	C., R. I. & P. R. R.
Reinbeck	929	C. G. W. R. R.
Wellsburg	1058	C., R. I. & P. R. R.
Whitten	1041	C. & N.-W. R. R.

The greatest altitude in the county is on the divide two or three miles southwest of Wellsburg. It is not likely to exceed 1080 feet. The range of altitude in the county is well within 180 feet.

Drainage

Save about forty square miles comprising the westernmost sections of Felix, Melrose and Shiloh townships, Grundy county lies in the Cedar river basin. The portion excepted above is drained chiefly by Pine, Bear and Dowd creeks, streams that after a short course to the southwest empty into the Iowa river.

The divide between the Iowa and the Cedar rivers nowhere runs more than four miles from the west line of the county. Wolf creek and its tributary, Little Wolf creek, drain about seventy square miles, including all of Clay and parts of Felix, Melrose and Palermo townships. All of German and Pleasant Valley townships, the north and east three-fourths of Shiloh and Fairfield, and the north fourth of Beaver townships are within the jurisdiction of Beaver creek. The run-off waters of all the rest of the county are taken care of by the Black Hawk and its tributaries.

With the exception of the South Beaver all the streams of the county have their sources within its borders. They are therefore all small and belong for the most part to the usual prairie stream type.

Most of the tributaries of the Iowa in Grundy county are very short headwater streams and have made no unusual impress upon the topography, but Dowd creek, by far the largest, which rises near the center of Melrose township and runs near to and parallel with the divide for five or six miles with a comparatively low gradient, having thus accomplished three-fourths of its course without distinguishing itself from the neighboring streams, suddenly turns towards the west and rapidly descends to the level of the Iowa through the deepest and most impressive valley of the county and yet one which in many regions of the Kansan area would appear very tame and insignificant.

Wolf creek, which without apparent good reason, bears the name of Big creek in the last ten miles of its course, enters the Cedar at La Porte City, Black Hawk county. It takes its rise in Melrose township two or three miles east of the sources of Dowd creek, nearly parallels the course of the latter for five or six miles and then, turning to the southeast, leaves the county near the southeast corner of Clay township. In the lower half of its passage it has a narrow valley with moderately low banks.

Formerly, perhaps, this valley was well wooded, but today only scanty traces of timber remain near Conrad and Beaman. Two small branches join it, the one some two miles west of Conrad, the other at Beaman.

The South Branch of the Beaver joins the main stream well within the borders of Butler county at Parkersburg. It has three principal sources; one in the southwest of Etna township, Hardin county, develops what is called the South Fork, another near Ackley, begins the Middle Fork, and the other in the north of German township, gives rise to the North Fork. These streams converge as they go eastward and unite their waters in section 28, Pleasant Valley township, beyond which the South Branch takes a northeasterly course to the Beaver, very directly as to its general course, but with numerous small sinuosities which indeed are quite characteristic. Farther east the northern border of the county is drained by small tributaries of the Beaver.

Fully one-half of the area of the county, including the central and eastern portion, is in the basin of Black Hawk creek, which enters the Cedar within the western limits of Waterloo. Its course in Black Hawk county is through a comparatively narrow valley, but in Grundy county it has a more decidedly dendritic character, though its contributing streams are usually small and without running waters during the dry seasons. The North Branch, however, is an important exception, as its drainage area includes one-third of the entire area of the Black Hawk basin within the county.

STRATIGRAPHY

Geological Formations

It has already been stated that outcrops of indurated rocks are almost wholly wanting in this county. It may be said further, that owing to the meager records of well drillers little reliable information in detail is obtainable concerning the position in the geological column of the rock that immediately underlies the Pleistocene deposits. It may be confidently determined, however, from the nearest outcrops in neighboring counties as well as data secured from well drillers that the Devonian underlies the northeastern part of the county and the Kinderhook stage of the Carboniferous is in all the other parts.

SYNOPTICAL TABLE.

GROUP.	SYSTEM.	SERIES.	STAGE.	FORMATIONS.
Cenozoic	Quaternary	Recent		Alluvium
		Pleistocene	Iowan	Iowan loess Iowan drift
			Kansan	Buchanan gravels Kansan drift
Paleozoic	Carboniferous	Mississippian	Kinderhook	Limestone
	Devonian	Upper Devonian	Lime Creek	Owen shale
		Middle Devonian	Cedar Valley	Limestone

DEVONIAN SYSTEM

Middle Devonian Series

CEDAR VALLEY LIMESTONE.

No exposure of this rock occurs anywhere within five miles at least, of the borders of this county. Neither have any wells been reported that give unmistakable evidence that the rock reached by them belongs to either of the common types of the Cedar Valley limestone. It is undoubtedly true, however, that the drift of the northeast corner of the county, including about ten square miles of Fairfield township and portions of Grant, Lincoln and Black Hawk townships is underlain immediately by the Cedar Valley limestone.

Upper Devonian Series

LIME CREEK SHALES.

Well drillers report finding at varying depths, in portions of Beaver, Fairfield and Grant townships a relatively soft, greasy,

homogeneous, blue clay, commonly known as "soapstone," beneath a shaly or somewhat fragile limestone and above a somewhat firmer textured limestone, in which water is found. The upper beds of limestone are recognized as the Owen limestone, outcrops of which occur a few miles northwest in Butler county. The blue clay answers to the description, both in character and position, of the Hackberry beds as given by Calvin* in his report on Cerro Gordo county. Accurate details of none of these wells were obtainable, but reports of all the wells in the territory named above agree as to the occurrence of rock material of the nature and order of succession given above. There can be no doubt then that the Lime Creek shales have a southeastward extension into Grundy county, at least to the neighborhood of Dike. Approximately correct well sections of this region are given later in this report.

CARBONIFEROUS SYSTEM

Mississippian Series

KINDERHOOK STAGE

While there is little superficial demonstration of the fact within the limits of the county, there is no doubt that by far the greater portion of the county is underlain with rock of the Kinderhook series. As has been stated elsewhere already the only actual rock exposures are on Wolf creek near Beaman and Conrad. At the latter place an abandoned quarry gives the only opportunity for an examination of rock in place where a section can be secured. Owing to the downwash of the soil and the mingling of the residual layer with the other layers below, as well as the accumulation of a considerable talus, much difficulty was experienced in securing anything like a satisfactory section. The following is a composite section secured from different points and may not be altogether exact.

	FEET.
3. Loam and loess	5
2. A greenish residual clay well filled with loose, cherty fragments and iron nodules	8
1. A yellowish gray, somewhat granular, but fine grained limestone, apparently made up largely of fragments of crinoid stems. Some layers near the upper part were crinoid fragments so loosely cemented and so little changed as to form a breccia after the manner of the Florida coquina	7

*Iowa Geol. Surv., Vol. VII, p. 161, *et seq.* 1896.

A section made by Professor Beyer eight or ten years before the above was taken is here quoted.*

		FEET.
5.	Drift (modified Kansan probably)	5
4.	Limestone, residual, consists chiefly of cherty concretions imbedded in a matrix of greenish clay streaked and mottled with ferruginous and marly material	3
3.	Limestone, slightly oolitic, composed essentially of a shelly breccia almost identical with No. 1 in the Eagle City section	4
2.	Limestone, hard, subcrystalline, containing numerous brachiopod casts	2
1.	Limestone, typical oolite in heavy beds, a Straparollus and a turreted form of gastropod were noted; also numerous brachiopod casts	5

The base of the section is about four feet below the Chicago and Northwestern railway track and 1,010 feet above tide.

Doubtless numbers 2 and 3 of the present writer's section were taken from the same portion of the quarry as were numbers 4 and 5 of Beyer's section, but as the rock below had been buried in talus at this point since the earlier section had been made, we were compelled to seek it at a point several rods away where it came out near the surface of the hillside, and where it had suffered weathering to some extent. This will account in part at least for the variations in the rock noted by the two observers.

It may be noted that the general character of the rock in number 1 of the writer's section readily suggests that found in Brower's quarry in section 17, Washington township, Butler county.† Outcrops of the Kinderhook in sections 28, 31 and 32, Washington township, Butler county, in some places within a half mile of Grundy county border, contribute very materially to the conclusion that the Kinderhook underlies the drift of the northeastern portion of Grundy. Well sections, while not very reliable, since the data were from memory of the well driller, indicate the same underlying rock horizon in interior portions of the county.

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*Beyer: Iowa Geol. Surv., Vol. X, pp. 270-271.

†See the writer's section of this quarry in his report in Butler county, present volume, page 37.

In 1909 Ford Brothers, contractors and prospectors of Marshalltown, sunk a deep well at Wellsburg which contributes somewhat to the data bearing upon the question of the eastward limit of the Hardin county lobe of the Des Moines stage; though by no means doing away with the difficulties connected with a satisfactory solution of the problem. The following is a section as supplied by Mr. E. A. Ford.

Surface elevation, 1,054 feet.

		THICKNESS.	DEPTH.
7.	Yellow clay with sand and gravel	80	80
6.	Blue clay	84	164
5.	Limestone, soft, porous, yellow, ferruginous	24	188
4.	Blue shale with thin strata of limestone and sandstone in upper part, and gray shale below interspersed as in upper part	222	410
3.	Bluish limestone	10	420
2.	Shale, highly fossiliferous	20	440
1.	Limestone, alternating strata, buff, white, blue and dark brown	117	557

Numbers 1, 2 and 3 are unquestionably Devonian, 2 and 3 being Lime Creek shales. As to the other numbers, comparison with the Ackley well, which is about ten miles to the northwest, is interesting. The elevation of the Ackley well is 1,115 feet. The drift is 100 feet thick followed by fifty feet of fine blue shale which in turn is succeeded by five feet of coarse buff sandstone. It is possible that close discrimination would determine the lower part of the blue clay attributed to the drift in the Wellsburg section, to be a blue shale corresponding to numbers 85 and 86 in the Ackley section. This would also account in part for the apparently unusual thickness of the drift at Wellsburg. Numbers 4 and 5 correspond very well in depth, thickness and general character to numbers 75 to 84, inclusive, of the Ackley well, though Mr. Ford did not give the details in his section. Norton* refers these numbers to the Carboniferous as an outlier and finds no Kinderhook represented. Beyer† in his report on Hardin county, from observations upon the elevation of the top of the Kinderhook and from outcrops of rocks of that stage in Hardin and adjacent counties and from outcrops of the Des Moines in that neighborhood, concludes that the

*Iowa Geol. Surv., Vol. III, pp. 191-192.
†Iowa Geol. Surv., Vol. X, pp. 262-263.

strata under consideration belong to the Kinderhook. It may be added that about nine miles north of Wellsburg and within three miles of Ackley along a tributary of the South Fork of the Beaver in Butler county there are escarpments of Kinderhook rock at an elevation from 1,000 to 1,050 feet. It may be said that the nature of these strata is more suggestive of the Des Moines than of the Kinderhook and their total thickness is very unusual for the Kinderhook, yet in other particulars they would be regarded as Kinderhook.

The summary of formations for the well may then be given as follows:

Pleistocene	164
Kinderhook	246
Devonian—	
Lime Creek	30
Middle	117

Pennsylvanian Series

DES MOINES STAGE.

From the presence of the Des Moines in Hardin county along the Iowa river in the neighborhood of Eldora and Steamboat Rock and eastward on Pine creek within two miles of the Grundy county line, it may be inferred that material of this series runs over into Grundy somewhat, though no certain proof of this is at hand. The writer has, therefore, followed the last state geological map in indicating the presence of the Des Moines in small portions of Shiloh and Melrose townships.

THE MANTLE ROCK

Residual Material

GEEST.

Naturally little material that is the result of local rock decay, or wastage, will be found in a region where the indurated rock is so completely covered with later deposits as is the case in Grundy county, but in the single locality where rock exposure does occur, there is to be found an unusual thickness of geest, or rock residuum. At the Conrad quarry it has a thickness of eight feet in places. It consists of a greenish clay marbled with numerous ferruginous streaks and blotches in which as a matrix lie small blocks of chert and iron nodules. The chert

was a part of the original rock, doubtless forming a band in the limestone, as is the case in much of the Kinderhook limestone of this horizon, while the iron nodules have concreted since the disintegration of the limestone.

A hundred rods, perhaps, east of Beaman a bank along the north side of the track of the Chicago and Northwestern Railroad gives a shallow section as follows:

		FEET.
3.	Loess	3-4
2.	Mingled sand, gravel and pebbles	1-2
1.	Residual material, a gray, or green marl or clay in which are fragments of a red brown sandstone and of a rock similar in color to the matrix	4-5

Owing to the slight inclination of the bank and the mingling of its components by wash, it was difficult satisfactorily to determine the thickness of each kind given above. The residuum was more of a marly character than was that at Conrad. It would seem that the upper portion of the original rock was a brown sandstone of no great degree of coherency, while the lower rock was a limestone, but distinct layers could not be made out, though the sandstone fragments appeared as a rule to be uppermost.

The material described above was largely, if not wholly, of preglacial origin. To be sure rock decay has always been going on wherever the weathering agents have had opportunity to operate, but the products have not been left in place to form a distinctive part of the rock mantle to any great extent, unless conditions were favorable. The preglacial products, for the most part, were borne away and intermingled with other forms of glacial debris to form that remarkable composite of incoherent earthy matter called till. Accumulations of geest of more recent origin are sometimes to be found where the moving ice sheet shattered the underlying rock and at last left it but thinly mantled with drift, so that weathering agents have had ready access to it ever since. Circulating waters have decomposed the walls of joints in the weaker rocks, leaving the insoluble portion to partially fill the spaces thus made. Oftentimes it is difficult to determine whether such accumulations were formed in the one or the other epoch, or perchance, in more than one.

The drift deposits also have suffered various forms of modification since they were laid down. Especially is this true of the superficial part of the Kansan, but such leached and otherwise modified drift is never classed with the other forms of residual earths commonly known as geest.

QUATERNARY SYSTEM

Pleistocene Series

KANSAN STAGE

Kansan Drift: No certain evidence of any glacial material older than the Kansan has been recognized in this county. The Kansan, however, is probably everywhere present, either as the superficial drift deposit or overlain with loess, Iowan till or alluvium. A satisfactory superficial line of demarkation between the two great drift sheets cannot be drawn, as their distinctive features insensibly fade away as they approach the border, or are more or less intermingled over a somewhat broad neutral zone. It seems not improbable that the Iowan ice sheet was extremely thin in this county along its southern border. Only a few of the smaller bowlders were carried along with it. Detached ice floes bore some of these down the swollen streams and left them well within the Kansan area. Low ridges of Iowan till were formed in places. Elsewhere the Kansan was ploughed up and mingled with the meager load of the Iowan. Portions of this thin ice border soon melted leaving the exposed surface to be veneered with loess in common with the neighboring Kansan.

The boundary as drawn upon the map is given tentatively and merely indicates where on one side the Iowan and on the other the Kansan features predominate. Yet on the north side of this line there are some areas that, taken by themselves, might well be regarded as Kansan, as for instance, ten or twelve sections in the immediate neighborhood of Fern, Beaver township; while on the south side of the line there are patches that in the same way might be regarded as Iowan, in illustration of which the country north and east of Ivester, Melrose township, can be designated. In general the whole drainage basin of the Black Hawk, excepting perhaps, that part lying south of that

creek in Black Hawk and Washington townships, may be included in the doubtful zone, while the area drained by the Beaver is unmistakably Iowan. Could careful and reliable data of well sections be secured generally over this doubtful area, all questions as to where this doubtful zone belongs would be settled, but such data have not been accessible.

Buchanan Gravels: While engaged upon the detailed survey of Buchanan county, Professor Calvin gave special consideration to certain gravel deposits that were well distributed throughout the county and which were particularly well displayed in certain pits that had been opened up by the Illinois Central Railroad. While they had been noted in several localities previously, they had escaped investigation as a specific deposit. Calvin now not only gave them a name, the Buchanan gravels, but described them so fully, that little that was really characteristic has been added since, and they have been accorded a permanent place in the geological column of the state. They occur generally over the Iowan drift area, and for some distance south of it, though no mention is made of them in the report upon Clinton county, and little note is made of them in Bremer, Benton, Cedar and Marshall counties. Macbride in his report upon Sac and Ida counties* and elsewhere mentions this formation beneath the Wisconsin and above the Kansan. It is noted by Udden† as of rare occurrence in Muscatine and Louisa counties, which are well without the borders of the Iowan.

The Buchanan gravels are accounted for as the result of outwash from the border of the melting ice as the Kansan glacier retreated northward. At first the swift flowing waters carried much unsorted detritus, but they soon lost their impetuosity and perforce dropped all the coarser part of their load. Later, gathered into well defined channels and proceeding with much dimished velocity, they aggraded their beds with the finer portion of their original burden. Thus are found two quite distinct phases of these gravels: the one, the upland phase, containing good sized pebbles, cobblestones and sometimes even bowlders a foot in diameter, the other, the valley phase, made up of material much more uniform in size, but varying in fineness with distance

*Iowa Geol. Surv., Vol. XVI, pp. 533-534.
†Iowa Geol. Surv., Vol. IX, pp. 339-340, Vol. XI, pp. 105-106.

from the ice border whence it had been taken. These gravels are always oxidized and iron stained. The granitoid constituents are usually in a condition of disintegration. The upland phase exhibits these features in higher degree usually than does the valley phase. Naturally there was much difference in the details attending their deposition and consequently as much variation in the conditions of the different beds, but the general agreement in their distinctive characteristics is quite obvious.

In the north half of the county sands and gravels that may be referred to the Buchanan formation without hesitation are not infrequent. They are of both phases and are usually of a character to make them valuable for use in improving the roads, though no such extensive use has been made of them for the purpose as in the adjacent counties of Butler and Black Hawk. The topography of the county has not favored the exposure of the beds to the same extent, and it is doubtful if the deposits themselves are as extensive in the main. At and around Grundy Center, Holland and Wellsburg, however, they are abundant, though the overlying loess makes access to them somewhat difficult. In the south half of the county sand and gravel are by no means common, especially in the four southwest townships. When found their appearance and relations both indicate that they are different in character and origin from the Buchanan gravels. As an instance, along the railroad an eighth of a mile east of Beaman, beneath three or four feet of loess, there is exposed a slope of four or five feet, the lower part of which is made up of a greenish marly clay in which are fragments of a gray-green rock. In the upper part the proportion of clay lessens, the rock fragments are of a red brown sandstone with which are mingled pebbles and gravel. At the top gravel predominates. This gravel does not seem to have been washed in here, but rather to have been part of the ground moraine pressed into and mingled with residual material. Similar conditions seem to prevail at the Conrad quarry.

IOWAN STAGE

Iowan Drift: The boundaries of the Iowan sheet of till in Grundy county, no less distinct, usually, in topography than in the character of the material of which it is composed, have been

considered under the topics, Topography and Kansan Drift. Little remains to be discussed in this place. Every feature of it finds expression in the county, leaving no chance for disputing its existence as one of the formations to be considered. In the north tier of townships firm granitic bowlders are everywhere to be seen and in some places, as in the west part of Pleasant Valley township and in some parts of Fairfield, they are unusual

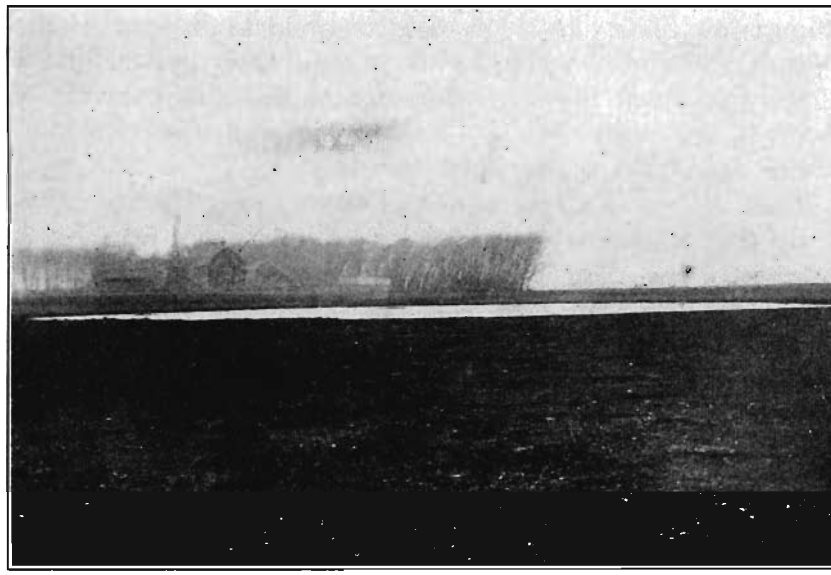

Figure 7. A small pond in the Iowan plain in the southwest quarter of section 5, Pleasant Valley township. Seen from the east.

both in numbers and size. The Iowan in this as in neighboring counties is relatively thin, nowhere exceeding eight or ten feet.

Modified Iowan Drift Forms: Near the middle of section 8, Beaver township, is a neat conical hill, rising higher than any of the surrounding elevations, which in this vicinity are relatively low. Near the middle of section 17 of the same township a cemetery has been located on a somewhat lower and broader hill. A road cuts the south slope of the latter near the base, exposing a rather fine sand somewhat oxidized and containing about five per cent of pebbles and an occasional cobblestone. Among the pebbles a few decayed granites and iron nodules were

seen. Eight feet of this material is exposed. There are indications that the whole elevation is made up of sand or gravel. These two hills a mile apart on a north and south line are unique in form and composition in this neighborhood. Superposed on Iowan till they suggest the kame, so common in some places as a feature of the landscape and, doubtless, should be classed with it.

Eight miles farther south in sections 30 and 31, Lincoln township, a low esker-like ridge of gravel and sand, with a northwest and southeast trend, terminates abruptly in a conical hill of sand of about the same elevation as those in Beaver township. A few rods south is a smaller hill, and within two miles two or three still smaller ones may be seen.

From the order of succession of these sandy elevations, it is likely that a subglacial stream loaded to its full capacity had its course here. Emerging from the free edge of the retreating glacier under some pressure and in the face of some hinderances it heaped up these cones one after the other, or, meeting with some obstruction while yet confined within the walls of ice, it aggraded its channel and thus formed the esker.

Bowlders: In the southeast quarter of section 32, Pleasant Valley township, is a pear-shaped, coarse grained, pink granite bowlder thirty-two feet long, twenty-eight feet wide and ten feet high, the extent of which underground is undetermined, but which apparently equals the height above ground. In the northeast quarter of section 13, Fairfield township, another coarse granite bowlder is twenty-seven feet long, twenty feet wide and seven feet above ground. It is quite regular in outline, flat topped, with a ridge running through the middle from north to south. This bowlder, in common with many others, has the reputation locally of being the largest in the state, but it may be noted that the one in Pleasant Valley mentioned above exceeds it in maximum dimensions, though it is not of uniform shape and possibly does not contain as many cubic feet. The western portion of Pleasant Valley township has an unusual number of large bowlders, as do portions of Beaver and Fairfield townships.

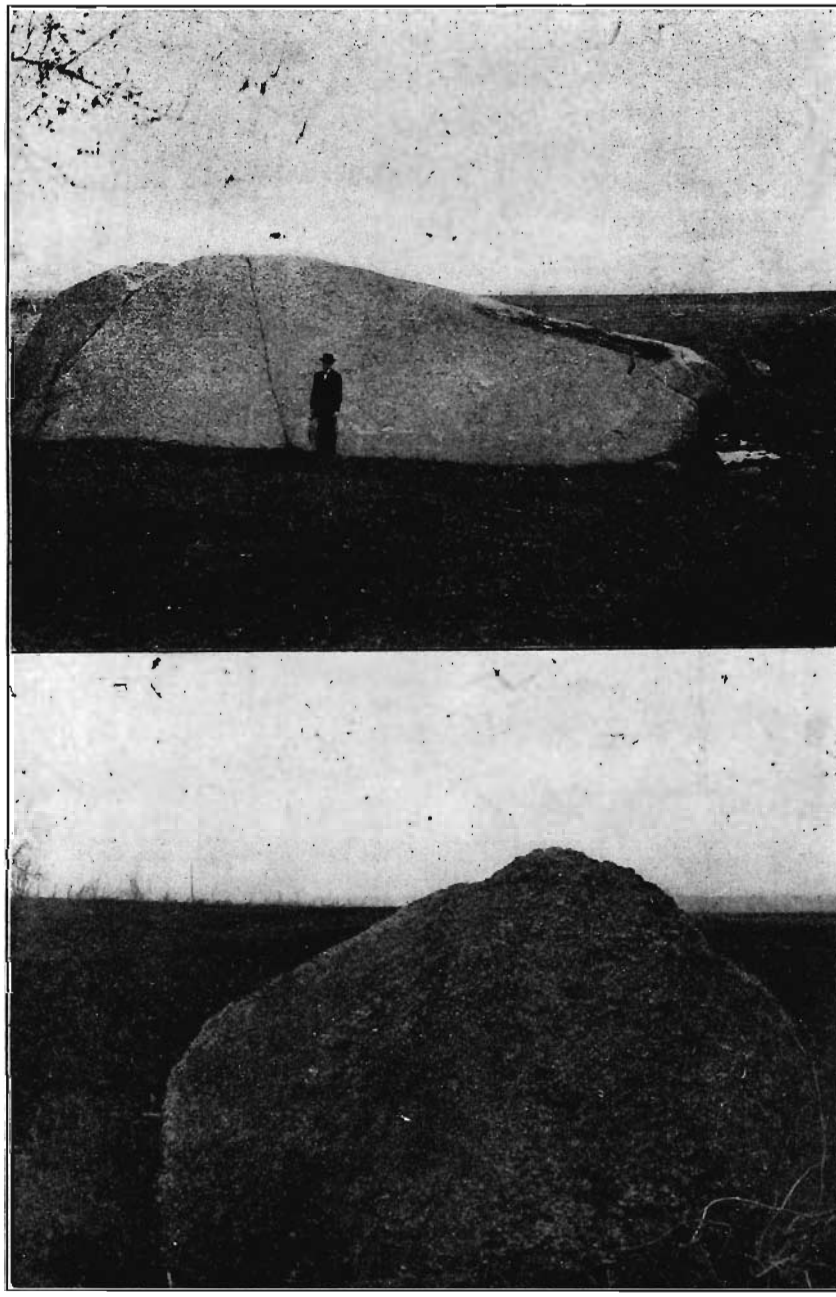

Plate XI. Upper view—Iowan bowlder of granite in section 32, Pleasant Valley township.

Lower view—Decaying granite bowlder in section 16, Pleasant Valley township. This bowlder is similar in composition and texture to that shown above.

Iowan Loess: Loess is the name given to that seemingly homogeneous, pulverulent, yellow to gray, silico-argillaceous earth usually overlying the Kansan till near the Iowan drift border, though rarely it lies upon the Iowan. In Grundy county it is an eolian veneer that is found very generally over the upland plains of the south half of the county, though the northern limit of its occurrence is as far south as Wellsburg in the west

Figure 8. A bowlder-strewn vale in the Iowan drift. Such swales are common in the northern tier of townships.

and nearly as far south as Reinbeck in the east. It also contributes the upper part of the paha in German township, where in a road cut it is exposed to the depth of about ten feet without revealing the nature of the immediate subjacent deposit. In the railroad cut at Wellsburg it has a thickness of six feet over Buchanan gravel. At the Brick and Tile Works at Grundy Center it has a depth of seven feet over Buchanan gravel.

A section taken here gives the following.

	FEET.
4. Yellowish gray loess	7
3. Gravel	1
2. Sand, gray with tinge of yellow, moderately coarse, with scattered pebbles of granite and greenstone. Sand grains are mostly a white or transparent quartz with a small per cent of red jasper and greenstone	12
1. Blue Kansan till?	

Water hinders excavation to a greater depth, but blue Kansan till is reported at no great distance below. Sand is reported as everywhere underlying the loess in Grundy Center, but it is not as thick elsewhere as given in the above section. The thickness of the loess, as given at the above named points, is believed to be exceptional, the average thickness being much less.

Alluvium

Deposits of alluvium are common in the valleys of nearly all the larger streams and are unusually widely extended near the confluence of the forks of the South Beaver in Pleasant Valley township and also in the region of the confluence of the branches of the Black Hawk in Black Hawk and Grant townships. Wolf creek and its branches have rather narrow alluvial plains or none at all, while the small tributaries of the Iowa river in Grundy are entirely without alluvium as their swift currents would prevent any aggrading whatever.

SOILS

Three types of soil prevail, those based respectively in the loess, Iowan till and alluvium. All are soils of exceptional richness and adaptation to the requirements of the Iowa farmer. Grundy county has always had the reputation of standing among the foremost of Iowa counties in its agricultural resources. Its population is almost exclusively engaged in farming and everywhere within its borders may be seen evidences of thrift and prosperity. There are no steep slopes, only in few localities are bowlders a real detriment, water distribution is equable and yet drainage is such as to rarely admit of the flooding of the cultivated alluvial areas to a harmful extent.

ECONOMIC PRODUCTS

Building Stones

Excepting the Conrad quarry and possibly one or two outcrops in the neighborhood of Beaman, there are no reasonable possibilities of obtaining building stone within the county. The Conrad quarry has been abandoned, since, with further progress, the thickness of the mantle rock increases rapidly, making the cost of the quarry product greater than that of equally good rock that can be shipped in from other localities.

Brick and Tile Making Material

The loess at Grundy Center and at Reinbeck and doubtless at other points is of excellent quality for brick and tile. At Grundy Center a brick and tile company under the management of Mr. F. D. Fronig is turning out a very good red brick the demand for which is in excess of the capacity of the plant. In 1906 the output was 700,000 tile and a half million brick. The company uses the stiff mud process, steam drying, a sixty horsepower engine, the car system and has three round, down draft kilns.

The Gethman Brick and Tile Company began operations at Reinbeck in 1904. The stiff mud process is in use here too. Both pressed face brick and common brick are made. Quality is excellent. The output in 1906 was twenty-five kilns of brick at 80,000 per kiln and thirteen kilns of tile at 25,000 per kiln. The round, down draft kilns are in use.

Sand

The sand uncovered by the removal of the loess at the brick and tile works at Grundy Center is of a character to make it suitable for all the ordinary purposes for which sand is used. Not only is Grundy Center and vicinity thus supplied, but many carloads are shipped annually to towns along the railroads that are less fortunately favored in this particular. The supply is apparently unlimited.

Road Materials

The Buchanan gravels are almost invariably excellent for improving the surfaces of country roads, especially if suitable provision is made for drainage. Any poorly drained road fails just

when a good road would be best appreciated. The custom of preparing a well drained roadbed and surfacing it with a good gravel or even a coarse sand has not been well established in this county, though the use of the gravels that are within easy access is beginning to be practiced in a number of localities. If every year the worst stretches of road were carefully improved as suggested above, it would not be long before travel would become very tolerable even in the worst seasons. The agitation for good roads and the spread of information respecting better methods of road making is having its effect very noticeably, and the discredit attaching to the rural roads in Iowa is very likely to be removed in the next ten or fifteen years, especially within the Iowan drift area, where the material for improving the roads is particularly abundant and most suitable.

Water Supplies

Springs: As would be expected in a region where there is little range of elevation within narrow limits, strong springs are not common, though an occasional seepage spring of real value may be found.

Wells: The general distribution of water courses with easy gradients has contributed largely to the necessities of stock in pasture. Where these have been wanting or have failed shallow wells have met the ordinary demands in the earlier settlement of the county. On the uplands dug or drilled wells ending in the drift were depended upon largely in the past. More recently deeper wells ending in or just above the rock, especially in the southwestern townships, have been resorted to. Accurate data of the wells have been difficult to secure. A few, though somewhat meager as to details, are here given.

At Conrad the public well is ninety feet deep, about sixty feet of which is in rock. In this neighborhood all wells are drilled, reaching rock at about twenty or thirty feet and ending in rock from sixty to one hundred feet from the surface. Water is of good quality and unfailing in supply.

Wells in Beaman are reported to be from fifty to ninety feet deep. They just reach rock, or go through the first bed which is not very thick, shaly in character and overlies a clay. The underlying rock is reported to furnish a better supply of water

and the later wells are seeking this supply. Most of the variation in the depth of these wells is due to the variation in surface elevation, which is considerable in this immediate vicinity.

In section 7, Clay township, a well is sixty-eight feet deep, in which Kinderhook limestone occurs at thirty feet. This is a region of flat Kansan topography. All wells in the neighborhood are reported quite uniform in depth and in reaching rock. Water is abundant and of good quality. In the southwest portion of Palermo township, where the topography is more varied, there is a corresponding variation in the depth of the wells, indicating that in all this neighborhood the surface of the indurated rock is very nearly level.

The public well at Reinbeck is 356 feet deep, about ninety of which is in rock. Sand is reported to interfere with the profitable use of meters, from which it is inferred that the water comes from a sandy aquifer, though it was not so reported in the data secured.

In section 24, Black Hawk township, drilled wells are in use. They have an average depth of 240 feet, forty of which are in rock. A few wells from eighteen to forty feet deep, ending in the drift, are in use in the low grounds. Drilled wells in the Black Hawk valley, which enter the rock, reach water at a depth just about as much less than those on the uplands as the hills are higher than the creek valley.

A well in the north half of section 10, on high ground, is said to be 370 feet deep. Depth in rock could not be ascertained. A well three miles northeast of Morrison is 270 feet deep, reaching rock.

A well near the center of section 5, Palermo township, is 110 feet deep, six or eight of which are in rock. Another in the east half of section 6 is 200 feet deep.

On the Merritt farm in section 2, rock was reached at 200 feet. Seven miles west of Grundy Center rock occurred at 100 feet.

Grundy Center has a public well, but no reliable data could be secured, beyond a statement that its depth was 450 feet.

On the Flater farm, in the northeastern part of Colfax township, the well is 294 feet deep, sixty-nine of which are in rock.

In section 20, Grant township, on Mr. Murphy's farm, the well is 195 feet deep, seven feet of which are in a firm white rock. At eighty feet a bed of sand thirty-five feet thick was found. A well near this struck rock at 200 feet.

Six miles south of Dike a well 180 feet deep ends in the drift.

In section 34, Lincoln township, a well eighteen feet deep furnishes a plentiful supply of good water, while in section 36 a well in the drift is 180 feet deep.

At Dike the public well is 260 feet deep. A section as reported by Mr. Frank Dann, the driller, is as follows:

		FEET.
4.	Sand	60
3.	Blue clay	40
2.	Sand	30
1.	A firm white limestone (Cedar Valley limestone?)	130

On Peter Johnson's farm, northeast quarter of section 12, Beaver township, the well is 274 feet deep as follows:

		FEET.
4.	Drift	112
3.	Shelly rock	14
2.	"Soapstone"	110
1.	Firm limestone	38

Making allowances for lack of accurate discrimination on the part of the driller and for possible errors in recalling the figures for the several depths, there is little room for doubt that number 1 is Cedar Valley limestone and numbers 2 and 3 are Lime Creek shales.

On William Wright's farm in the northwest quarter of section 13, Beaver township, the well is 310 feet deep, 200 feet in rock, passing through the "soapstone."

On Robert Fortune's farm in the northeast quarter of section 7, Fairfield township, the well is 231 feet deep, 110 feet in rock. Thirty or forty feet of soapstone were penetrated.

Numerous other wells in Fairfield and Beaver townships are reported as entering or passing through "soapstone." The same reports are made across the border in Butler county, from which it is manifest that the Lime Creek shales extend across Butler into the northeastern part of Grundy county, but no reliable data show their occurrence anywhere in the townships

IOWA GEOLOGICAL SURVEY

GEOLOGICAL MAP OF GRUNDY COUNTY, IOWA.

BY

M. F. AREY

1910.

Scale 1:62500

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
KINDERHOOK

UPPER DEVONIAN
LIME CREEK

MIDDLE DEVONIAN
CEDAR VALLEY

THE SOUTHERN MARGIN OF THE IOWAN DRIFT IS INDICATED BY THE BROKEN LINE. THE AREA IN GERMAN TOWNSHIP INCLOSED BY THE BROKEN LINE IS LOESS-KANSAN.

INDUSTRIES

QUARRIES

CLAY WORKS

GRAVEL PITS.

R. XVIII W. R. XVII W. R. XVI W. R. XV W.

T. 89 N. T. 88 N. T. 87 N. T. 86 N.

GERMAN VALLEY PLEASANT BEAVER FAIRFIELD

SHILOH COLFAX LINCOLN GRANT

MELROSE PALERMO WASHINGTON BLACK HAWK

FELIX CLAY

Fern Fredsville P.O. Dike Wellsburg Holland Zaneta GRUNDY CENTER Ivester Morrison Reinbeck Whitten Conrad Beaman

IOWA LITHO. CO.

DRAWN BY E.C. ATE

south of Fairfield and Beaver. It is doubtless true that the southernmost boundary of the Lime Creek shales is not far from the south line of these townships.

A well put down by the municipality of Wellsburg, a section of which is given under another chapter, presents the following data:

It is situated upon a side hill 200 feet from the postoffice. It is 557 feet deep. Its diameter for the first 325 feet is ten inches, for the rest of the distance it is eight inches. The principal aquifer is a soft porous limestone underlying the drift at a depth of 164 feet. At 400 feet a less important aquifer was found. Water rises at the maximum of eighty feet from the surface and at a minimum of 230 feet. A Smedley deep well lift pump operated by a gasoline engine brings the water to the surface at the rate of twenty-five gallons per minute. No analysis of the water is at hand, but it is reported to give traces of iron and sulphur. It is used to supply stores and residences, the number of consumers being one hundred.

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