State of Iowa

1926

Sketch of

The Geology of Iowa

Issued by the
Iowa Geological Survey
George F. Kay, Ph. D., Director
James H. Lees, Ph. D., Assistant State Geologist

Published by
THE STATE OF IOWA
Des Moines

PUBLICATIONS OF THE IOWA GEOLOGICAL SURVEY

VOL. I, 1892. Free. Geological Formations; Cretaceous Deposits of Woodbury and Plymouth Counties. Ancient Lava Flows in N. W. Iowa; St. Louis Limestone in Mahaska County; Catalog of Minerals; Niagara Dolomites; Bibliography.

VOL. II, 1894. Free. Coal Deposits. Superseded by Vol. XIX.

VOL. III, 1893. $1.10. Cretaceous Deposits of Sioux Valley; Devonian and Carboniferous Outliers in Eastern Iowa; Section along Middle River; Glacial Scorings; Paleozoic Strata of N. E. Iowa; Iowa Chalk; Buried River Channels in S. E. Iowa; Gypsum; Geology of Lee and Des Moines Counties.

VOL. IV, 1894. Out of Stock. Geology of Allamakee, Linn, Van Buren, Keokuk, Mahaska, Montgomery Counties.

VOL. V, 1895. $1. Geology of Jones, Boone, Warren, Washington, Woodbury, Appanoose Counties.

VOL. VI, 1896. Free. Lead and Zinc; Sioux Quartzite; Artesian Wells; Wisconsin and Kansan Drifts in Central Iowa.

VOL. VII, 1896. $1.30. Geology of Johnson, Cerro Gordo, Marshall, Polk, Guthrie, Madison Counties.

VOL. VIII, 1897. $1.30. Geology of Dallas, Delaware, Buchanan, Decatur, Plymouth Counties; Iowa Building Stones.

VOL. IX, 1898. $1.45. Geology of Carroll, Humboldt, Story, Muscatine, Scott Counties; Artesian Wells of Belle Plaine.

VOL. X, 1899. $1.85. Kinderhook Fossils of Burlington; Geology of Lyon and Sioux, Osceola and Dickinson, Hardin, Worth, Dubuque Counties; Flora of Lyon.

VOL. XI, 1900. $1.45. Geology of Louisa, Marion, Pottawattamie, Cedar, Page, Clay and O'Brien Counties.

VOL. XII, 1901. Free. Geology of Webster, Henry, Cherokee and Buena Vista, Jefferson, Wapello Counties.

VOL. XIII, 1902. $1.40. Geology of Howard, Kossuth, Hancock and Winnebago, Mills and Fremont, Tama, Chickasaw, Mitchell, Monroe Counties; Lithographic Stone.

VOL. XIV, 1903. $1.40. Clays and Clay Products: Technology, Chemistry, Geology, Tests, Power Plants.

VOL. XV, 1904. Free. Cement; Geology of Benton, Emmet, Palo Alto and Pocahontas, Jasper, Clinton, Fayette Counties.

VOL. XVI, 1905. Free. Geology of Winneshiek, Clayton, Bremer, Black Hawk, Franklin, Sac and Ida, Jackson Counties; Flora of Winneshiek.

VOL. XVII, 1906. Free. Quarry Products: Cement, Lime, Power Plants, Geological Section, Geology, Analyses, Tests.

VOL. XVIII, 1907. Free. Devonian Fishes of Iowa.

VOL. XIX, 1908. Free. Coal: Geology, Fuel Values, Analyses, History of Mining, Statistics, Section of Des Moines Stage, Carboniferous of S. W. Iowa, Bibliography; Peat: Geology, Bibliography, Flora.

VOL. XX, 1909. Free. Geology of Butler, Grundy, Hamilton and Wright, Iowa, Wayne, Poweshiek, Harrison and Monona, Davis Counties.

VOL. XXI, 1910, 1911. Free. Underground Waters: Topography, Climate, Geology, Artesian Phenomena, Chemistry, Mineral Waters, Waters by Districts.

VOL. XXII, 1912. Free. Bibliography of Iowa Geology: Geographic, Geologic, Mining Work; Bibliography.

(Continued on page 16)

SKETCH OF THE GEOLOGY OF IOWA

Geological Map of Iowa

The Iowa Geological Survey is engaged in preparing a geological map of Iowa, upon a scale of half an inch to the mile. That is, a half inch on the map represents a mile upon the surface of the ground. This map is issued in a series of sheets, each covering a county. The sheets are printed as fast as they are prepared. Each is accompanied by a text forming a report upon the area represented by the map, describing its surface features, its geological structure, and its mineral resources. The sheets and accompanying descriptive texts issued in any one year are bound together to form, for that year, the annual report of the Survey. A few hundred copies of each county report are, however, bound separately and issued as pamphlets. Necessarily the text accompanying any one map is concerned with the geology of the particular area to which the map refers, and to that alone.

Similarly the Survey has, ever since its organization, been making special studies of the different geological formations of the state, their extent and thickness, the character of the different kinds of rocks included, something of the contained fossils and the economic value of the formations. Careful examinations have been made of the various economic minerals and their distribution, geology, properties and uses. Reports have been published giving this information regarding cement materials, clays, coal, gypsum, iron, oil and gas, sand and gravel, stone and lime, underground and river waters. A number of special subjects have been studied, including a few groups of fossils, some geographic topics and others of geologic interest. Suitable maps accompany many of these reports.

For the benefit of readers unfamiliar with geology, who may not receive the full set of publications of the Survey, it has been thought desirable to furnish a brief resume of the geology of the state as a whole.

Character and Origin of Rocks

Geologists deal almost exclusively with rocks, but rock, in the wide, scientific use of the term, includes all classes of earthy or stony material, whether consolidated or not. Soft chalk, softer clay, or the loose bed of sand or gravel—if produced by natural physical agents, such as currents of air or water—is to the geologist as much rock as the hard granite bowlder occasionally found in our prairies. In accordance, however, with the somewhat prevalent notion, the rocks of Iowa may be divided into hard and soft, into indurated and nonindurated rocks, into the regularly-bedded deposits that are recognized as rocks by even the nongeological observer, and the loose superficial materials that almost everywhere conceal the beds of the indurated series. The hard or indurated rocks of Iowa are made up mainly of limestones, sandstones and the various forms of shale, all of which, however, differ among themselves very greatly in the matter of hardness. The indurated series of the state as exposed at the surface does not include any volcanic rocks, for nowhere, except at a few points now buried beneath some hundreds of feet of later beds, is there any evidence that Iowa ever included volcanic centers.

The hard, regularly-bedded rocks of Iowa were formed almost exclusively under water. They were originally loose, soft sediments spread out where they now lie, in regular sheets or layers, on the bottom of ancient seas. The present sandstones were originally submarine sand banks, the shales were beds of mud, the limestones were the products of coral reefs or marine shells of various kinds, broken and ground into fragments, and the coal seams were first masses of vegetable matter accumulated in swamps or marshes, something as similar matter accumulates in modern peat bogs. The areas in which coal accumulated differed from modern peat bogs, however, in the fact that they were almost exclusively salt-water marshes, limited to what was, at the time of coal formation, the continental borders. That the rocks of the indurated series in Iowa are mainly of marine origin is clearly indicated by a number of lines of evidence; but it may be sufficient to note that the shells, corals, and other organic remains, so generally found imbedded in the various strata, are all of marine types. They are skeletons of creatures that lived in the waters while the rocks were forming, and they are of such types as could live nowhere but in the sea. They tell not only of the presence of an ocean over certain parts of Iowa at the time the sediments in which they are imbedded were laid down, but they reveal the character, condition, and stage of development of the marine life of the globe during the successive far-away periods that collectively make up geologic history. The rocks in question, therefore, so far as relates to Iowa, are nothing more than the consolidated sands and muds of old sea bottoms preserving for our inspection samples of the life that occupied the seas at the time each successive bed was in process of accumulation. Iowa has passed more time under the ocean than as dry land.

Over the hard or indurated rocks that constitute the foundations of the state there is spread a covering of unconsolidated materials ranging from a few inches to more than 500 feet in thickness and forming the soils and subsoils which are so important an element among the many causes of Iowa's prosperity. This nonindurated rock series includes several sorts of material. There is (*a*) the fine sediment—clays, sands and gravelly loams—laid down by rivers on their bottom lands and called *alluvium;* (*b*) the red sticky clay, in some cases mixed with fragments of flint or chert, resulting from the slow decay of limestones where rocks of this kind have been long exposed at the surface. This clay is called residual clay because it is what is left after certain parts of the limestone have been carried away in solution; in some of the publications of the Survey, following the suggestion of a recognized authority on the subject of superficial deposits, it is called *geest.* There is also (*c*) the fine clay, ranging from yellow to buff in color, free from all pebbles but containing little balls of lime and occasionally shells of land snails, with very rarely a few shells of fresh-water species. This fine pebbleless clay is called *loess.* It has been gathered by the winds from the river flats and barren plains and heaped up in great mounds or spread out over the prairies; it is an aeolian deposit. Lastly, there is (*d*) the blue, black, yellow, or buff bowlder clay with associated gravels and sands, and not infrequently containing masses of granite or other rock species not native to the state. These materials, constituting by far the greater portion of the nonindurated, or soft rock series of the state, were laid down by great glaciers or ice sheets which, several times in succession, crept down from the north over all, or parts of Iowa. The bowlder clays of glacial origin are spoken of in the literature of geology as *drift* or *till.*

The superficial materials, including the drift, loess, geest and alluvium, are the newest or youngest of the rock series of the state. It must be kept in mind that the rocks naturally exposed within the limits of Iowa were not formed simultaneously. Some, as already noted, originated as sediments which were slowly and progressively piled up on the bottom of ancient seas; some were transported and spread out by glaciers; some originated in other ways; but whatever may have been the genetic process, in such a region as Iowa the order of age among the different beds coincides with the order of superposition.

The Geological Succession

The very oldest rock in the state is that popularly known as Sioux Falls granite, or Sioux Falls jasper. It happens, however, that the rock is neither granite nor jasper, but is a quartzite. Geologists call it the *Sioux quartzite.* It was originally a loose bed of sand; but in the lapse of time it has been changed, by a very perfect process of cementation, into one of the hardest and most durable of rocks. The Sioux quartzite outcrops at the surface in the northwestern corner of Lyon county, but elsewhere in the state it is concealed by newer strata. It is sometimes encountered in wells, and the depths at which it may be reached differ with the location of the well. At Holstein it was reached at 1,970 feet, at Tipton at 2,245 feet and at Lansing at 751 feet. The same formation appears again at the surface in central Wisconsin, where it is known as the *Baraboo quartzite.* The Sioux quartzite makes splendid structural material, either as dressed stone or as crushed rock, and will take a high and enduring polish. It belongs to the Huronian series of rocks.

The rock next in age to the Sioux quartzite, so far as relates to Iowa, is found along Mississippi river between McGregor and the northeastern corner of the state. This formation is largely sandstone. In the geology of Minnesota and in the reports of the present Iowa Survey it has been called Saint Croix or Croixan; but in much of the literature relating to the geology of the region it is known as the Potsdam sandstone. Wells bored in this sandstone at Lansing reached the underlying quartzite at a depth of 700 feet below the water level of Mississippi river. The same sandstone rises in the bluffs up to a height of 300 feet above the river, thus giving the formation, at Lansing, a total thickness of about 1,000 feet. The Lansing bluffs are capped with 100 feet of Oneota limestone, the formation next younger than the Croixan; and the road ascending to the highlands, six or seven miles west of the river, leads over the outcropping edges of the upper part of the Prairie du Chien, the whole of the Saint Peter and the basal portion of the Mohawkian. The order

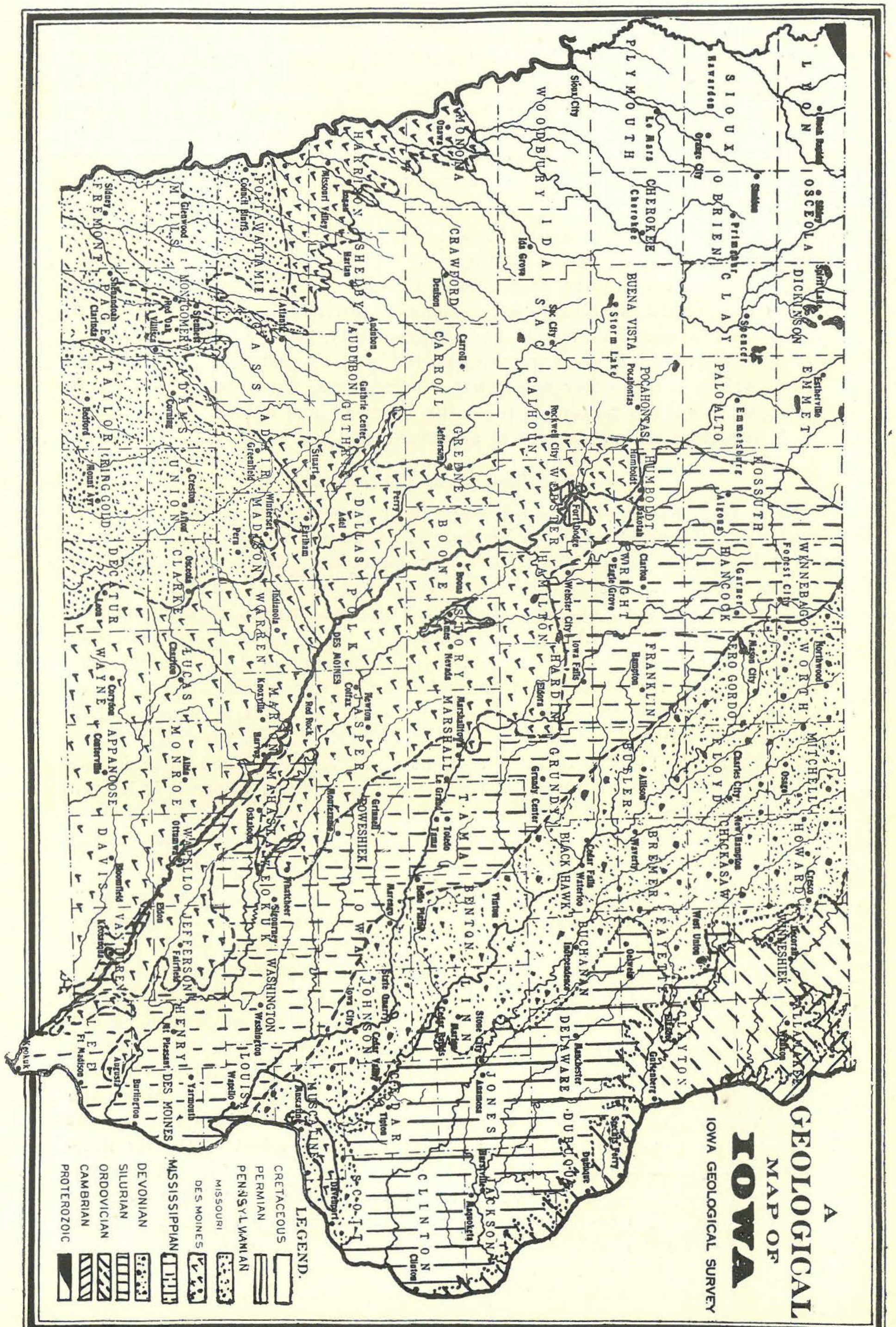

Fig. 1. Geological Map of Iowa.

of superposition and consequently the order of age, is here definitely determined for the five formations named. Or if one follows the Oneota valley westward he will pass successively the Jordan (the upper Croixan) sandstones beyond the east border of Winneshiek county, then the limestones of the Prairie du Chien with the interbedded New Richmond sand-

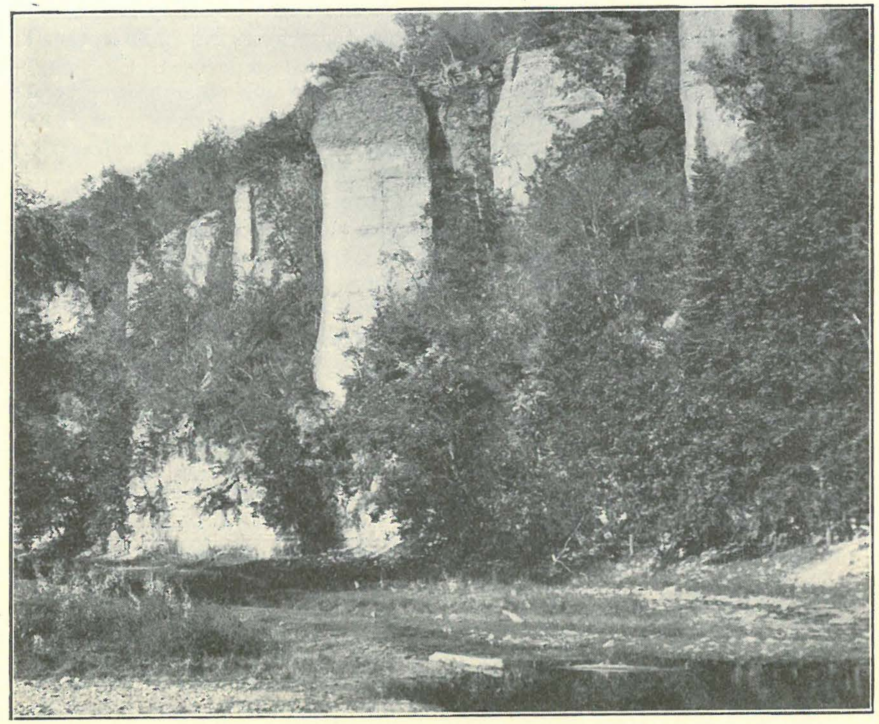

Fig. 2. The rivers of northeastern Iowa have cut their valleys into solid rock. Oneota or Upper Iowa river flows beneath vertical cliffs in some parts of its course, as at the spot near Bluffton in Winneshiek county, shown in this view. The rock here is the Galena limestone.

stone, then the Saint Peter sandstone and in the vicinity of Decorah the Platteville limestone and the Decorah shale. Farther up stream the Galena limestone forms massive cliffs and battlements along the walls. In the southwestern part of the county the shales and limestones of the Maquoketa underlie the hills and over them lie the Devonian beds, which here overlap and extend beyond the Niagaran border. Farther south in the state, however, these Niagaran dolomites are the dominating elements in the stratigraphy, and in the topography also. Both the Niagaran and the Devonian beds have a wide distribution in northeastern Iowa, because they underlie a fairly level land, unlike the older strata, some of which outcrop only in the hillsides.

Farther west and south, beyond the Devonian area, lie the varied deposits of the Mississippian, a great belt of shales and limestones which extends from Keokuk on the southeast to Forest City and on into Minnesota on the northwest. The shales and sandstones and the coal beds of the Des Moines series cover a wider stretch of territory, from Humboldt to the Missouri line and from Des Moines river for miles on either side. Cut through these beds and into the Mississippian beds below in the neighborhood of Fort Dodge is a great valley which was filled during Permian time with a thick bed of gypsum and with red sandy shales to a total depth of about eighty feet. Another patch of Des Moines beds lies just under the drift in southwestern Iowa. It is exposed at Logan, in Harrison county, but is known chiefly by wells and other borings.

Southwestern Iowa is underlain by a series of shales and limestones with two thin coal seams which collectively are known as the Missouri series and which have a thickness of over 600 feet. They extend as far north as Earlham and Atlantic. After the formation of these beds Iowa was land for a long time. During this period, however, the Permian sea may have extended into the Fort Dodge region from Kansas. But when the ocean again invaded the region it came from the northwest rather than from the southwest or south as had been the case previously. Hence the Cretaceous sandstones and shales overlie the older beds without any regard to the positions which these older strata occupy. The lower Cretaceous beds, called the Dakota sandstones, are products of fresh water deposition but the Colorado shales and limestones are marine. The distribution of these various formations is shown in the geological map given in figure 1 and their vertical succession is given in figure 4, the general geological section of the state.

Economic Resources

The Croixan is the best water-bearing horizon in Iowa, owing to its wide outcrop in Wisconsin and Minnesota, and the Saint Peter forms the next most reliable aquifer. The lead and zinc of Dubuque county were found in the Galena limestone. The different limestones of the state yield abundant supplies of crushed and dressed stone, notably the Ordovician and Silurian. The cement plants at Mason City get their stone and shale from the Devonian. The plant at Gilmore uses stone from the local beds of Mississippian age, which also supply the Pyramid plant at Valley Junction, while the Hawkeye plant near Des Moines gets shale from the Des Moines series and limestone from the Missouri. On account of its stores of coal and shale the Des Moines series comprises probably the most important rock strata of Iowa. The rocks of Saint Louis age at Centerville contain a bed of gypsum which is being used for making wall plaster and the extensive bed of gypsum in the Permian system at Fort Dodge supplies several large mills which manufacture various kinds of building materials. The great shale formations of the state, such as the Maquoketa, the Kinderhook, the Des Moines and the Colorado, also the glacial drift sheets, supply numerous clay works with raw materials for brick, tile, pottery and other wares. Sand and gravel beds in the drift or in stream valleys, and to a less extent beds of sandstone, supply the demands for these materials for building, road construction and other uses.

Disposition of Strata

During the progress of deposition of the sedimentary, or indurated rocks of Iowa that are younger than the Croixan sandstone the northeastern corner of the state together with a large adjacent area was gradually elevated or tilted up, hence the shore line of the sea in which the strata were successively laid down retreated step by step towards the

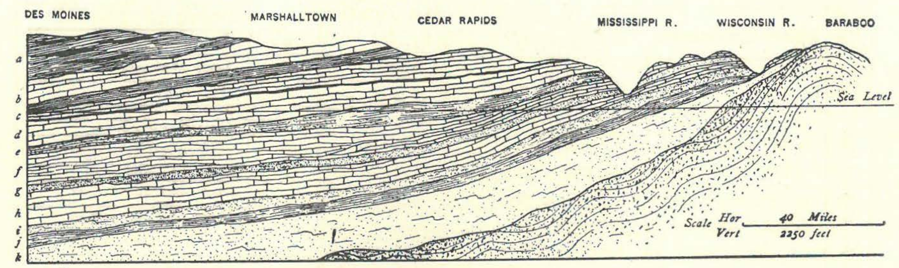

Fig. 3. Geological section from Baraboo, Wisconsin, to Des Moines, Iowa, showing the general stratigraphy of the region. The drift is not shown. The chief aquifers are the Saint Peter, the Jordan and the Dresbach sandstones. The line of juncture of the Dresbach sandstone and the underlying Huronian is hypothetical. *a* Des Moines; *b* Mississippian; *c* Devonian; *d* Niagaran; *e* Maquoketa; *f* Galena-Platteville; *g* Saint Peter; *h* Prairie du Chien; *i* Jordan sandstone; *j* Saint Lawrence; *k* Dresbach.

southwest. Accordingly the successively younger rocks are found at the surface in parallel belts as one travels from the northeast to the southwest. Each formation dips to the southwest and so passes under the next younger as is shown in the accompanying diagram, figure 3, except that in the figure the inclination of the beds is necessarily very much exaggerated. By drilling a well at Des Moines, for example, the sandstone that crops out in the hills near Lansing is found at a depth of 2,000 feet beneath the surface; and at Des Moines we can pump out water which has filtered through the porous layers of the formation all the way from outcrops of the sandstone in Wisconsin and northeastern Iowa.

Grouping of Rocks

Rocks have their individual characteristics. Those laid down during any one period of geological history have certain peculiarities whereby they may usually be distinguished from the rocks of any other period. The rocks which represent a single period of geological time constitute a system. Systems are assembled into groups, and each system may be divided and subdivided into series and stages. All divisions of whatever rank, from groups to stages, and even to substages, are severally known to geologists by definite names. The general section given in figure 4, in which the rocks of Iowa are represented diagrammatically in the order of age or superposition, shows (1) the manner in which the indurated rocks are subdivided, (2) the relations of the several members of the geological column one to the other, and (3) the names used to designate the several geological units, or natural groups of units as they are recognized in the publications of the Survey. The table shows the strata that

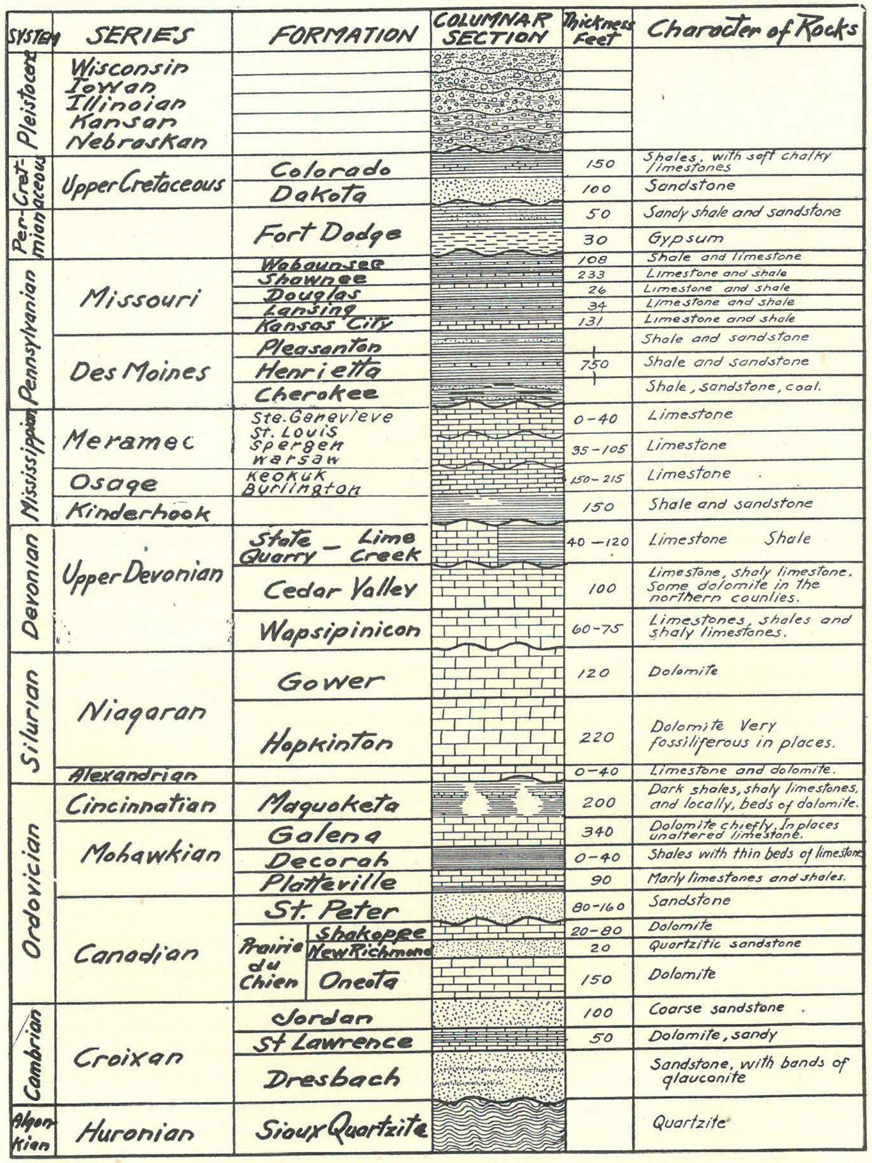

Fig. 4. General Section of the Rocks of Iowa.

would be penetrated in boring a well, provided it were possible to locate a well so that it would pass through each formation, and pass through it at its maximum thickness.

Probably the Greenwood Park well at Des Moines shows this succession as well as any in the state. The record of this well follows. The curb is 872 feet above sea level.

	Thickness Feet	Depth Feet	Elevation of base above sea Feet
Pleistocene	14	14	858
Des Moines	484	498	374
Meramec and Osage....	200	698	174
Kinderhook	160	858	14
Devonian	80	938	-66
Silurian	507	1445	-573
Maquoketa	33	1478	-606
Galena	460	1938	-1066
Decorah	8	1946	-1074
Platteville	40	1986	-1114
St. Peter	39	2025	-1153
Shakopee	124	2140	-1277
New Richmond	94	2243	-1371
Oneota	175	2418	-1546
Croixan, penetrated ...	582	3000	-2128

It will be noted that many of the formations bear geographic names. These names are derived from localities where the beds are well exposed or typically developed. Thus the Des Moines stage is named from the river along which the beds of this age are found as surface rocks; the Saint Louis from the city where the formation was first studied; the other geographic names have similar reasons for their application.

Irregularities of Strata

In the section given as figure 4, and in all the similar figures published by the Survey, sandstone is represented by dotted patterns, shale by lines, limestone by blocks, and drift by lines broken by small circles. Irregular lines between two formations indicate unconformity. For illustration there is in many places an unconformity between the Saint Louis or the Ste. Genevieve limestones of the Mississippian system and the Des Moines series of the Pennsylvanian. This means that at the close of Meramec time the sea bottom on which the sediments making up this series had accumulated was elevated and became dry land. Streams and atmospheric agents carved this land surface into hills and valleys, producing such irregularities as these same agents have wrought over the present surface of southern Iowa. Eventually, however, the region subsided and what had been dry land became covered with sea. New sediments—those making up our Iowa Coal Measures—were spread out unconformably, the geologist would say, over the carved and uneven surface. Unconformity quite generally records, for the region in which it is seen, the following succession of events: (1) Elevation of sea bottom above sea level, (2) erosion and trenching of the exposed surface, (3) subsidence, and encroachment of the sea, (4) deposition of new sediments over the carved and irregular surface. There is a marked unconformity between the Cretaceous and the Pennsylvanian, and there is another, equally as marked, between the Pleistocene deposits and nearly the whole series of indurated rocks. While the drift and other superficial materials were not laid down in the sea they yet rest on an eroded and irregularly carved surface.

Rocks like our sandstones, shales and limestones that originate as sediments accumulated on a sea bottom are as a rule spread out in even, regular, continuous and practically horizontal sheets. Various causes tend to interfere with the regularity of the original deposition. By reason of strains in the earth's crust the beds may be folded or tilted, or the continuity may be interfered with by fractures and displacements. Marked departures from the original continuity and horizontal position of the beds are known as *deformations.*

The best known of these deformations in Iowa is a great break in the strata which is called the Thurman-Wilson fault, along which the strata have been displaced about 280 feet. It extends across southwestern Iowa from Missouri river near Thurman in Fremont county to Earlham, west of Des Moines, and limits sharply the extent of the Missouri strata to the northeast.

Range of Altitudes

Iowa lies within the Mississippi valley and forms a part of the great prairie plain of the interior. In general its surface shows but slight relief, the local differences in elevation being comparatively insignificant. The vertical range of surface elevations in the state is about 1,180 feet, from 490 feet above sea level at the mouth of Des Moines river below Keokuk to about 1,670 feet above sea level on Ocheyedan Mound, Osceola county, and a similar elevation on the prairies northeast of Sibley, in the same county.

Distribution of Glacial Drifts

The northeastern corner of the state includes a region which has not been invaded by glaciers since the first or Nebraskan ice sheet melted away and in fact a small area here is a portion of the famous driftless area, a region which was never covered by glaciers. So long has this region, both driftless and Nebraskan, been exposed to erosion that the surface is practically not at all modified by glacial materials. It is entirely the resultant of erosion acting on the bed rock and hence is the most rugged part of the state and contains the most beautiful scenery. The hills in places rise abruptly 300 to 500 feet above the river valleys and the country back from the rivers slopes up to divides that are 300 feet higher than the marginal bluffs. Thus the Mississippi at Lansing, in Allamakee county, is 612 feet above sea level and Iron Hill near Waukon in the same county is 1,320 feet above sea. Moreover the valley of the Mississippi has been filled with alluvium to a depth of 150 feet or more.

As was intimated in the preceding paragraph the earliest of the glaciers was the one known as the Nebraskan. Doubtless this glacier and its resulting drift sheet covered the entire state with the exception of the true driftless area as defined below, but this drift is now entirely hidden by that of later glaciers except in that strip of northeastern Iowa

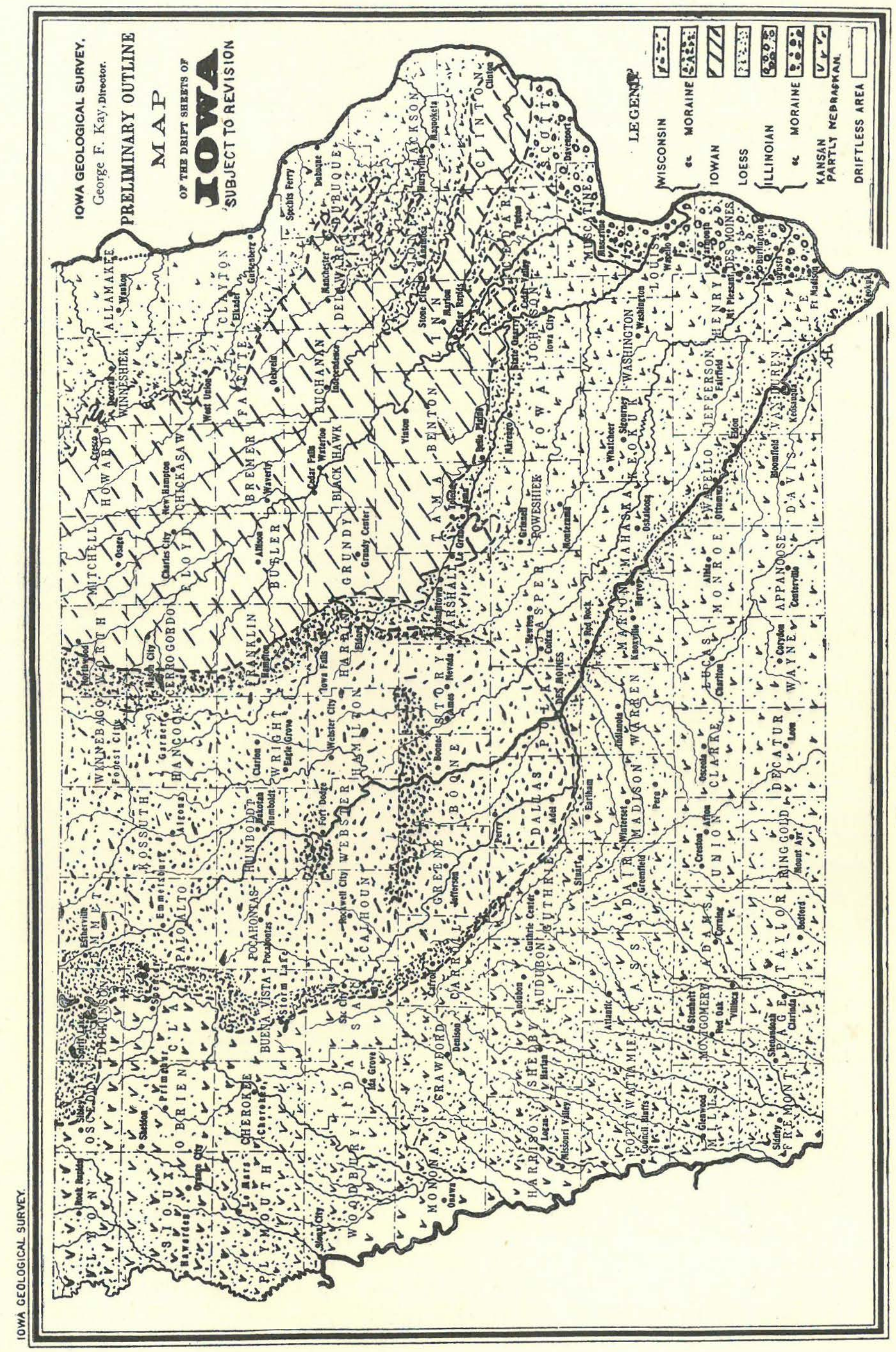

Fig. 5. Glacial drift sheets of Iowa.

which lies east of the ill-defined Kansan boundary line which extends from eastern Winneshiek to northern Jackson counties. From this area the drift has been almost entirely eroded away, so that for a long time it was all considered to be a part of the driftless area. The actual driftless area is now believed to be confined to that part of Allamakee county which juts farthest eastward within the great bend of the river. Exception should be made also of the many stream valleys which have been cut through the later drifts and into or through the Nebraskan, leaving the lowermost drift exposed in their walls or floors. These areas again are too indefinite to permit their being mapped.

Fringing this old Nebraskan drift area on the west and covering almost the whole of southern Iowa as well is the region of what is known as the Kansan drift. While the surface here is quite uneven the hills are rounded and less abrupt than in the Nebraskan and the driftless areas,

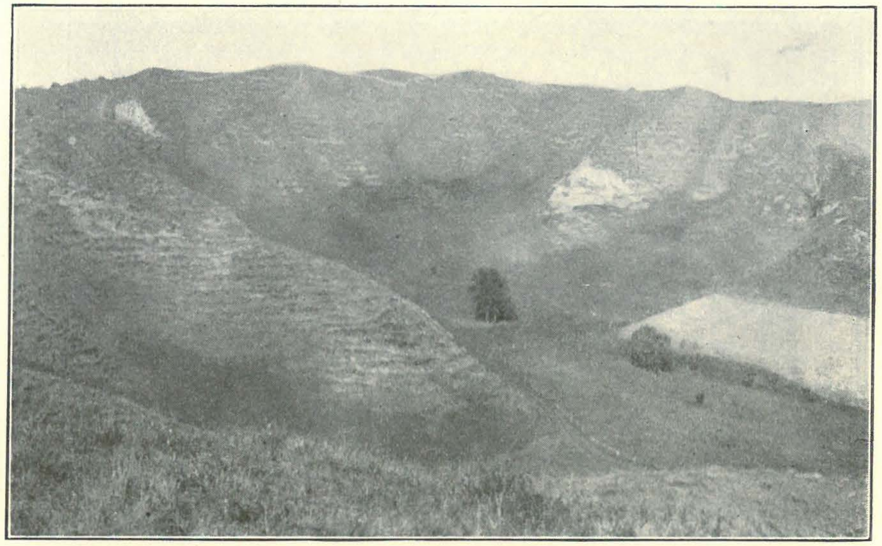

Fig. 6. The valleys of western Iowa are sunk almost entirely in the soft clays of glacial and aeolian origin. Wind and rain have combined to form this amphitheater in the drift and loess which form the east wall of the Missouri valley near Turin in Monona county. The loess is nearly a hundred feet thick in some places along these bluffs. Note the characteristic wavy outline of the hilltops.

and the valleys, though wide, are comparatively shallow. As in these areas, however, the surface irregularities are due to the fact that streams have cut trenches in a once continuous plain. In an area in northeastern Iowa having Bremer and Buchanan counties as its center the valleys are broad sags in the surface, they have not been produced by erosion, the streams wander hit and miss among irregular hills, and there are several gravel knolls and erratic land forms due not to stream cutting but to the heaping up of material by glaciers. In north-central Iowa west of Cerro Gordo, Franklin and Hardin counties, there is an area of still

younger drift, an area from which the glaciers retreated so recently—perhaps 10,000 to 25,000 years ago—that the majority of the streams have not yet established definite channels. There are numerous undrained areas—sloughs, ponds, kettle holes and lakes. This is the lake region of Iowa, the characteristics of which become more pronounced in its northward extension into Minnesota. The drift covering the region is called the Wisconsin; that of the area represented by Bremer and Buchanan counties is the Iowan, and a drift occupying a small area in southeastern Iowa is called the Illinoian. In much of the area not occupied by Iowan and Wisconsin drift the surface material is the loess already referred to. With the exception of the Nebraskan and the driftless areas in the northeast and the Illinoian area in the southeast, the loess, in general, rests on Kansan drift. Most of it was deposited soon after the retreat of the Iowan glacier, though some may have been formed since. It is in general thickest along the great rivers and along the margin of the Iowan drift sheet and thins out toward the interior of the Kansan area. Belts of irregular, piled up hills mark the margins of the Illinoian and Wisconsin areas. These are the terminal moraines and similar belts within the Wisconsin drift plain are known as recessional moraines.

Value of Iowa Soils

Because of the fact that Iowa soils are based almost entirely upon the drift and the loess these are to the farmer the most important of the geological formations of the state. Where the loess has been enriched by the growth and decay of plant life it forms a rich soil, and the same is true of the drift where it forms the surface. Great care is needed in rolling areas to properly conserve the black surface soil, the humus, as when it is once washed off ages are needed to renew it.

Glaciers and Rivers

The incursion and retreat of the ice sheets that spread out the various drifts mentioned, coming as they did at widely separated times, have had much to do with the rivers of Iowa. The streams have been pushed around, blotted out, made to reverse their courses and changed so many times that many of the present stream channels bear little relation to preglacial, or even interglacial lines of drainage. Some of our main river valleys are a patchwork of bits of a number of old independent valleys pieced together. For example, while some parts of the Mississippi valley are older than the glacial period and are very deep and wide, other parts are so recent that the river has not yet cut away the rock bottom nor widened its valley greatly and the stream is affected by shallows and rapids, as at Rock Island and Keokuk. The Des Moines valley below Des Moines is post-Nebraskan in age, north of here it is of post-Kansan origin as far up as Bradgate in Humboldt county, beyond which locality the valley is post-Wisconsin, that is, postglacial.

PUBLICATIONS OF THE IOWA GEOLOGICAL SURVEY

(Continued from page 2)

VOL. XXIII, 1912. Free. Pleistocene Mammals of Iowa.

VOL. XXIV, 1913. Free. Road and Concrete Materials: Geology, Description by Counties, Tests, Analyses; Analyses of Sixteen Coals.

VOL. XXV, 1914. Free. Iron Ore Near Waukon; Iowa River in Johnson County; Maquoketa Trilobites of Fayette County; Origin of Dolomite; Des Moines Valley.

VOL. XXVI, 1915. Free. River Waters; Iowan Drift; Pleistocene Deposits between Manilla and Coon Rapids; Pleistocene Geology of N. W. Iowa.

VOL. XXVII, 1916. Free. Geology of Ringgold, Taylor, Clarke, Cass, Adair Counties; Large Boulders in Kansan Drift; Wapsipinicon Breccias.

VOL. XXVIII, 1917, 1918. Free. Gypsum: Physical and Chemical Properties, Origin, Deposits, Geology, History, Technology, Uses, Tests.

VOL. XXIX, 1919, 1920. Free. Oil and Gas; Lake Calvin; Missouri Series; Maquoketa Echinoderms of Fayette County; Devonian Crinoids.

VOL. XXX, 1921, 1922. Free. Mississippian System in Iowa.

VOL. XXXI, 1923, 1924. Free. Fertilizers; Light-burning Clays; Cambrian Trilobites; Sulphur in Iowa Coal.

BULL. 1. Out of Stock. Grasses of Iowa, Part I.

SUPPLEMENTARY REPORT. Free. Grasses of Iowa, Part II.

BULL. 2. Free. Peat; Tests of Coal. Superseded by Vol. XIX.

BULL. 3. Free. Cement Materials. Superseded by Vol. XVII.

BULL. 4. 50 cents. Weed Flora of Iowa.

BULL. 5. Free. Rodents of Iowa.

BULL. 6. Free. Iowa Birds of Prey.

The Region about Camp Dodge.

Geological Map of Iowa.

Map Showing Glacial Drift Sheets of Iowa.

Vol. XXXII
XXXIII
XXXIV