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that the various bitumens, including natural gas, are genetically connected with and are closely allied to marsh gas, and that they are produced by the natural decomposition of organic tissue. Natural gas closely resembles in composition the inflammable marsh gas which is often observed coming from the muddy bottoms of stagnant ponds. The following analysis, giving the mean results of seven analyses made for the United States Geological survey by Prof. C. C. Haward, will show the composition of natural gas:

Marsh gas	93.36
Nitrogen	3.28
Hydrogen	1.76
Carbon monoxide	.53
Oxygen	.29
Olefiant gas	.28
Carbon dioxide	.25
Hydrogen sulphide	.18
Total	100.03

Marsh gas, the principal constituent, is a simple compound of carbon and hydrogen in the proportions of 75 per cent of the former to 25 per cent of the latter.

The natural gas of the Pleistocene deposits of Iowa is then simply the product of the decomposition of the vegetable remains buried in the drift.

RESULTS OF RECENT GEOLOGICAL WORK IN MADISON COUNTY.

BY J. L. TILTON.

OUTLINE.

1. The geological formations of the county.
2. The distribution of the alluvium, loess and drift.
3. The relation of present drainage to preglacial drainage.
4. Terraces.
5. The areas occupied by the Des Moines and Missourian stages of the coal measures.
6. The transition from the Des Moines to the Missourian stage.

It is intended in this paper to state briefly some of the geological features of Madison county as observed during the

past summer. For a more detailed description, reference may be made to the complete report in the next volume of the "Iowa Geological Survey."

The county is thoroughly drained, the uplands well dissected by ravines that have left no swamps. The streams have well established grades over loess and drift. Only at the heads of smaller ravines is present erosion still in progress. Such a drift topography is again approaching maturity.

Above the flood plains of the streams a line of low, rounded knolls rises about six feet. These constitute a river terrace in the normal development and mark the highest limit of spring floods. About fifty feet above the bed of Middle river the remains of a second terrace are found in various places along the stream. At various points terrace-like places appear along the hillsides. Some of these are undoubtedly dependent on the resistant character of underlying strata. As a whole they bear so little relation one to another and to the river bed, that they are judged not to be terraces dependent on former stages of water in the stream, but of local character dependent on the differential weathering of the hillsides.

The geological formations of the county are given in the following table:

CLASSIFICATION OF FORMATIONS IN MADISON COUNTY.

GROUP.	SYSTEM.	SERIES	STAGE.	SUBSTAGE.
Cenozoic.	Pleistocene.	Recent.		Alluvium.
		Glacial.	Iowan.	Loess.
			Kansan.	Drift.
Paleozoic.	Carboniferous	Upper.	Missourian. Represented by the Winterset limestone.	
			Des Moines.	

Alluvial deposit is to be found in the broad river valleys. It generally lies on loess extending down into the river bottoms.

The loess deposit of the county occupies the divides, and extends over the hillsides into the river valleys. It is quite thin over the entire county, excepting east of Barney, where large hills of loess are banked against the adjacent Missourian limestone. The loess here is stratified, seeming to be made up of wash from the unstratified loess. In the east central and northeastern parts of the county the loess is more sandy than as usually found. The loess consists of two parts, an upper and a lower; the lower is more clayey than the upper, but no soil line has been observed between the two parts within the bounds of the county. The line between the two may have some relation to the soil line first observed at Churchville, Warren county, by Bain, and to the line of separation between the upper and lower loess at Indianola described in the report on the "Geology of Warren county."*

The Kansan drift is very heavy in the northeastern, southeastern and southwestern parts of the county. It consists of the usual reddish-brown gravel containing subangular waterworn pebbles of various light colored granite and quartz, together with greenstone and reddish quartzite pebbles and boulders. Below this gravel is a clay with numerous pebbles scattered through it, that, under the action of running water, form numerous little pot-holes in the beds of ravines that cut into this clay in the southeastern part of the county. There are no characteristics at present known whereby the relation of this lower part of this Kansan drift to the sub-Aftonian, or Albertan, drift may be determined.

There is no Wisconsin drift within the limits of the county, but the loess on the hills in the northeastern part of the county is quite sandy. Near the boundary between Lee and Jefferson townships, the northeastern townships, various outcrops of Des Moines strata protrude from the hillsides, while in the western part of Jefferson township they are concealed by the drift.

The loess lies unconformably on the Kansan drift, and the drift unconformably on the Carboniferous strata.

The relation of the drift to the underlying strata reveals the general plan of the preglacial drainage as contrasted with the present drainage.

* "Geology of Warren County," in Iowa Geological Survey, vol. V, p. 318.

The dotted line represents the boundary line between the surface outcrops of the Des Moines strata on the east and the Winterset strata on the west. The main points of difference

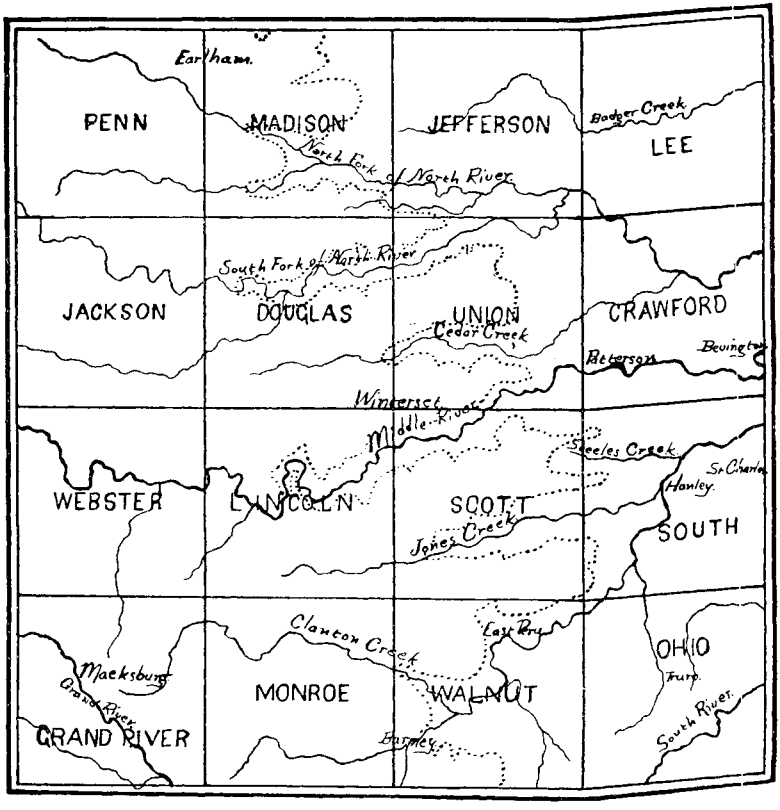

Fig. 1. Present drainage of Madison county.

are as follows: The drainage of Jefferson township was southeastward along the front of the Winterset limestone to North river. Because of the drift, Badger creek now flows northeastward over the drift across Jefferson township, then southeastward across the pre-Kansan divide, then eastward across Lee township. The stream seems to follow pre-Kansan ravines, but does not cut through the drift.

A preglacial valley extends southwestward from the western part of Lincoln township across the southeastern part of Webster township and thence across Grand River township. This old valley is now completely filled by drift, and the drainage, which was formerly turned toward Middle river, is now turned

southeastward into Grand river, a stream that is post Kansan in Madison county. Middle river, west of Lincoln township, formerly uniting in section 21 of Lincoln township with the

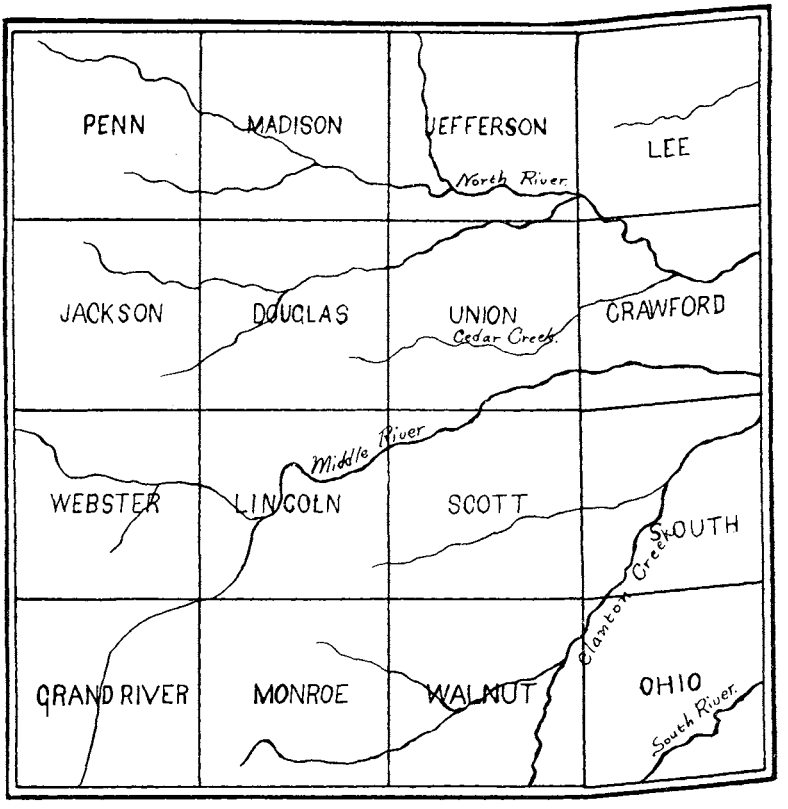

Fig. 2. The lines of preglacial drainage in Madison county.

stream from Grand River township, flowed in a large curve northward and then eastward, leaving in the bow thus formed that delightful and somewhat romantic "Devil's Backbone."

East of Barney the main part of Clanton creek seems to have flowed northward across section 35 of Walnut township.

The following streams are in preglacial valleys of their own: North river, Middle river, South river, Clanton creek, and the principal parts of Cedar creek, Jones creek and Steels branch; but the valleys are all much modified by the drift, and there is evidence of long-continued erosion during the time that was post-Kansan and preloessal. The smaller ravines forming the heads of the larger ravines are post-glacial.

The geest, the weathered coal measure surface of preglacial times, forms no important part of the soil. It is completely obscured by drift and loess, excepting where exposed by erosion.

The strata underlying the drift in the eastern part of the county belongs to the Des Moines stage of the coal measures. The strata underlying the drift in the western part of the county belongs to the Missourian stage of the coal measures. The dividing line between the surface outcrops of these stages may be traced as an irregular line across Madison township, the northeastern part of Jefferson, the central part of Douglas, Union and Lincoln townships, the eastern part of Scott and the central part of Walnut townships. (See figure 1.) The general surface of the limestone to the west of this line is higher than the surface of the shales east. This difference in elevation, together with the presence of preglacial valleys along the eastern margin of the Missouri limestone except in the divide just south of Patterson, make the limestone form an escarpment across the county.

East of the dividing line the strata are generally clayey or sandy shale, but there are outcrops of a layer of limestone from one and a half to two and a half feet thick, especially important in the neighborhood of Truro, hence here called the Truro limestone. It outcrops along South river at an altitude of seventy feet above the river bed, and on both sides of Clanton creek valley. It outcrops along the hillsides in Crawford township, and appears near the crests of divides between Lee and Jefferson townships. Its distance below the base of the Winterset limestone is eighty feet.

While in the Des Moines shales, unconformity is common, and in the sandy shales south of Patterson ripple-marks are to be found only forty feet below the Winterset limestone, there is no unconformity whatever between the base of the Winterset limestone and the uppermost Des Moines shales. This gives evidence that, just prior to the time when the Winterset limestone was deposited in the county, the shore line was farther inland (east or northeast) of the present limits of the limestone, and, with the gradation from sandy shales with ripple-marks, through clayey shales to Winterset limestone, sustains the conclusion previously advanced by Keyes that the Missourian limestone was formed in an advancing sea.

The succession of strata in the Winterset limestone is as follows, with uniform general characteristics throughout the county:

13 ft.	Limestone, very shaly above, lower part heavier but with varying thickness of marly partings. This forms the base of the Missourian limestone.
2 ft. 8 in.	Shale, clayey, gray above, black below.
4 in.	Limestone; dense, jointed.
9 in.	Shale, clayey, gray.
6 in.	Limestone, irregular, gray, fossiliferous.
2 ft. 6 in.	Shale, clayey, gray.
1 ft. 9 in.	Limestone, irregularly concretionary.
9 ft. 6 in.	Sandstone, shaly, gray.

In section 22 of Lincoln township the shales that are clayey in outcrops found in the northern part of Scott township, are calcareous shales, giving evidence clearly visible that the uppermost part of the Des Moines shales gradually changes into limestone toward the southwest. This necessary condition has been generally recognized concerning the Des Moines shales as a whole, but no transition now visible has to my knowledge been pointed out, unless it be in the deep well records of Montgomery county.

While there may be a marked difference in fauna between that of the Des Moines stage and that of the Missourian,* such distinctions as exist in the fossils seem satisfactorily referred to oscillation causing varying conditions of depth in the water with no very marked break. When the bottom of the sea was depressed, the deeper water fauna migrated into this deepening water. When the bottom was elevated, the deeper water fauna moved farther out to conditions more favorable, while their place was taken by a shallow water fauna. Of course if the Winterset limestone, and its shore equivalent, were laid down in an advancing sea, there must have been unconformity beneath the deposits somewhere, but not where the strata are still existing in Madison county. The changes in depth of water are accompanied by changes in the character of the strata. These

*University Geological Survey of Kansas, vol. I, p. 181.

changes, based on the succession of strata within the county, may be represented in the on following diagram:

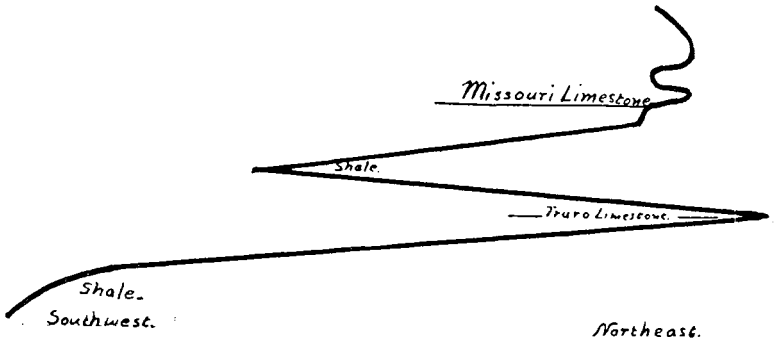

Fig. 3. Diagram representing the relative positions of the shore lines as indicated by the general character of the strata within Madison county.

NOTE.—A later comparison of outcrops proves that those shales in the upper Des Moines which are mentioned in this paper as calcareous, lie a few feet above those to the east with which they were compared; hence the local evidence mentioned that the upper part of the Des Moines shales becomes calcareous toward the west is wanting.—AUTHOR.

DRIFT SECTION AT OELWEIN, IOWA.

BY GRANT E. FINCH.

Just outside the limits of the growing town of Oelwein, Iowa, to the southeast, the Chicago Great Western Railroad company, in order to lessen a troublesome grade, have excavated a cut nearly a mile in length. At the end farthest from the town, where it passes diagonally through a ridge, it has a maximum thickness of thirty-two feet. This ridge has a northwest-southeast trend, and is one of the ordinary gentle swells characteristic of the drift of this region.

To pass along the front of so extensive a section, twice the depth of ordinary drift cuts, fresh and untarnished by sun and rain, is a pleasure to any one, whether geologist or not. The great variety of colors—strata black, brown, gray, blue, green, and several shades of yellow; the distribution of boulders like plums in a Christmas pudding; the intricate twistings and turnings of some layers and the unexpected, fantastic intrusion of others, all could not help but hold the eyes of both trained and untrained observers.

Though of great interest throughout its entire length, the section exposed where the cutting pierces the before-mentioned