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Origin of the Present Drainage System of Warren County

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places the alternating quartzitic layers are only one or two inches in thickness, and are each separated by several inches of loose sand. By selecting the sand grains near the quartzite and examining them carefully under a microscope, the grains may be found abundantly showing secondary enlargement. In many cases the crystalographic faces are well defined, and the common hexagonal pyramid of typical quartz is found perfectly reproduced, each with a sand grain inside. In many instances the sand grain is especially well defined for the reason that red oxide of iron has filled the irregularities in the surface. It appears, then, that in these enlargements there is a more or less rounded irregular grain, thickly coated with iron oxide, and around this has been deposited secondary quartz with crystal faces often well defined. As the secondary enlargement goes on the contiguous grains become closely interlocked, forming the compact vitreous quartzite which is so well known.

ORIGIN OF THE PRESENT DRAINAGE SYSTEM OF WARREN COUNTY.

J. L. TILTON.

SYNOPSIS: *First.*—In Warren county the drift is of uneven depth. As in other drift areas, this unevenness is not dependent entirely on the pre-glacial surface. In the unconformity of the drift on this pre-glacial surface a relation is seen indicating a similarity between the present drainage system and the pre-glacial drainage system.

Second.—The present river valleys and larger ravines are larger than present streams require. They fit into the pre-glacial valleys.

Third.—In the smaller ravines only do we find erosion without regard to the pre-glacial configuration of the county.

In connection with field geology work in the northern part of Warren county and the adjacent townships of Madison county, a question of constantly increasing interest to me has been this: To what is the present drainage system of the county due? I will endeavor to make clear an answer to this query, without too much detail, leaving other questions to be presented at some future time.

It is generally understood that the drift is laid in irregular deposits, here thick on the hill-tops, there thick in the valleys. Are we to expect, then, that the present drainage system has been marked out since the "Ice Age," with little regard for the previously existing systems? It is true, that in the county referred to there is no regularity in the depth of the drift deposit. At times the drift rests on sandstone, at times on limestone, at times on shale.

Two-thirds way from Indianola to Spring Hill is a valley; its sides with equal pitch. The road down the east side shows Carboniferous outcrops

very prominently, while by the road down the west side is a drain, cutting deep into loess, without a trace of Carboniferous strata. A little east of this ravine is another ravine crossing the road, cutting through loess and various Carboniferous strata; here is an excellent illustration of unconformity, for within a hundred feet the surface of the Carboniferous strata slopes northward, in the direction of the present drainage, allowing the loess to rest successively on clay shale, coal, fireclay and shale.

Indianola is built on a hill thickly capped with drift, while a hill east of Carlisle has shale, clay, and coal out-cropping in the road, even near the top of the hill.

To see the bearing of these illustrations of unconformity, let it be remembered that the old surface was exposed to erosion during untold centuries from the close of the Carboniferous Age till the "Ice Age." In that long period there was opportunity to cut out the immense valleys occupied for ages then as now, by small streams. The unconformity of the drift on this ancient surface reveals the direction of drainage in pre-glacial times. This unconformity indicates that the more prominent ravines of the present lie in pre-glacial ravines, though frequently on one side of the ravine.

At present three rivers carry the surface water to the Des Moines. At times in the spring these rivers are filled till their flood plains are submerged, but ordinarily they are nearly dry. Making what seems due allowance for high water in spring, one cannot help but wonder how these streams could cut into Carboniferous strata or even wash away drift material till each little river had such broad flats as those to be seen north of Greenbush on North river, at Summerset on Middle river, and south of Indianola on South river.

Comparing the ravines that open into these rivers, we notice that where the surface rocks are least easily decomposed there the sides of the ravines are steepest and out-crops most easily found, while in sections where the surface rocks are soft, as north of Lathrop, there the sides of the ravines are rounded and out-crops less frequently found; yet over it all the loess is generally undisturbed. Some of these main ravines cut deep into loess, while the same deposits are apparently as deep on the knolls that separate parts of the ravine. Back from the main ravines reach the smaller ones, rarely cutting deep enough to remove anything but loess.

East of Buffalo bridge a valley nearly a quarter of a mile wide is cut through a hill fully a hundred and seventy feet high composed of masses of limestone, but the ravine mentioned now contains a stream nearly dry the larger part of the year. What little water there is in this gorge flows northward.

Comparing the valleys running to the north with those running southward there is nothing to indicate that one set has been favored more in its formation by either ice or water from melting ice masses. We should naturally expect ice moving from the northeast to gouge out the soft material lying on the north slopes near the tops of the hills; yet such material is still found exposed. At the unconformity mentioned where the ravine opens to the northward the strata referred to are very exposed to such erosion. The valleys sloping to the northward have no characteristics in common, distinguishing them from valleys sloping southward. Especially is it difficult to conceive how ice, or water from a melting ice mass, could erode such a

valley as that mentioned as lying just east of Buffalo bridge, Madison county, or of those in White Oak township, Warren county.

A similar statement may be made in regard to the river valleys. The rivers wander here and there over a partly alluvial plain with drift along the margins, at times even on the very banks of the rivers themselves.

Comparing these different data it is clear the river valleys were marked out chiefly in pre-glacial times. During Mesozoic and Tertiary times when this region was subject to constant erosion, wide valleys were cut into the carboniferous strata as deep as the present valleys. While the drift is an important factor in the present configuration of the country, yet in the region referred to the ice had little to do in erosion, and the waters from melting ice sought in general the natural previously determined drainage courses thus keeping open the rivers and many of the chief ravines of pre-glacial times, while only the lesser ravines have been marked out since the drift was deposited.

STRUCTURE OF THE MYSTIC COAL BASIN.

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The lower measures of the Iowa-Missouri coal field consist of a series of sandstones, shales, fire clays and coal beds, which have been found to interlock in a characteristically irregular manner. The different individual beds have, with rare exceptions, only a limited extent, and frequently grade into each other in a manner making their stratigraphy quite complex. This variability has been recognized by many workers* and has recently been elaborated† so fully that only a reference is necessary in this connection.

The explanation of the irregularity is found in the conditions of the depositions of the beds. It depends primarily upon the facts indicated so abundantly by the nature of the beds themselves—that these measures are marginal depositions, and it has been suggested‡ that in this field the lower coal measures represent the marginal deposits, of which the upper coal measures are the, in part, contemporaneous open sea beds.

In certain portions of the field the irregularities may be directly traced to the influence of the uneven nature of the floor upon which the beds were laid down.

*Swallow: Rep. Mo. Geol. Sur., p. 87, Jefferson City, 1855.
Worthen: Geol. of Iowa, vol. I, p. 250, 1858.
Broadhead: Rep. Mo. Geol. Sur., II., p. 166. Jefferson City, 1872.
Norwood: Rep. Mo. Geol. Sur., pp. 200-215, 1873-1874. Jefferson City, 1874.

†Keyes: Stratigraphy of the Carboniferous in Central Iowa; Bul. Geol. So. Am., II., pp. 277-292, 1891.
Winslow: Mo. Geol. Sur., Prelim. Rep. on Coal, pp. 21-22, 1891.

‡Winslow: Missouri Coal Measures and the Conditions their Deposition; Bul. Geol. Soc. Am., III., 109-121, 1892.
Keyes: Geol. Sur. Iowa, vol. I., First Ann. Rep., pp. 84-85, Des Moines, 1893.