

place, accompanied by a rapid evolution of oxygen. The compound itself does not produce such a change, neither does ammonia, but only the solution of the one in the other. It was found that copper sulphate dissolved in ammonia will behave in the same manner.

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## RIPPLE MARKS IN HUDSON LIMESTONE OF JEFFERSON COUNTY, INDIANA.

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In the proceedings of the Indiana Academy of Science for 1901, and in a paper entitled: Concerning Well Defined Ripple Marks in Hudson River Limestone, Richmond, Indiana. Prof. Joseph Moore and Allen D. Hole describe Hudson limestone ripple marks near Richmond, Indiana.

In this paper I desire to give briefly the location and some points of description of similar markings in the Hudson limestone of Jefferson County, Indiana. In this county, to my knowledge, Hudson limestone ripple marks occur in five widely separated localities and at six different horizons. In all essential points the accurate and full description of the ripple marks at Richmond may be applied to those mentioned in this paper.

The geographical positions of the Jefferson County markings will be given in the order of their geological horizons, the Clinton limestone being used as a basis for measurements. Following this a few of the principal points of interest touching the ripple marks will be included.

The Wolf Run ripple marks are found at the roadside and in the creek bottom within 200 yards of the end of the Ryker's Ridge pike on Wolf Run in Madison Township. In this place there are two quite distinct series of markings. The upper is in a stratum approximately seventy feet below the Clinton outcropping on the neighboring slope. The lower is in a stratum some six or eight inches below the first. The upper series of marks are exposed over a space some 35x8 feet, while the lower is exposed over a surface of some three or four square yards. The trend of the crests of the upper marks is N. 70° E., and of the lower N. 50° E., approximately. I say approximately since there are many small irregularities in the trend of the crests. These crests are, however, essentially

parallel. The stone in which all the markings spoken of in this paper occur is the blue, abundantly fossiliferous limestone, so characteristic of the lower and middle Hudson formation in the region of the Cincinnati geanticline. The fossils found in the various ripple marked limestones vary with the horizon in which they occur.

The thickness of the stratum containing the upper Wolf Run marks is from two to three inches, while that of the lower is from one and a half to two inches. The distance from crest to crest or wave length is in the upper series twenty-one inches, and in the lower eighteen inches, approximately. The depth of trough in the upper is one and a half inches, and in the lower one to one and a half inches.

The Clifty Creek series of markings occur in the bed of that stream at a point about one and one-fourth miles above the bridge on the Madison and Hanover pike. The ripple marks are exposed in this place at intervals for a distance of 200 yards. The trend of the crests here is N. 10°-15° E., quite a little irregularity being noticed. The distance from crest to crest is from thirty to thirty-six inches, and the depth of trough three inches. The thickness of stratum five to seven inches, and the approximate vertical distance below the Clinton limestone, 190 feet.

In the bed of the West Fork of Indian Kentucky Creek, one-third of a mile above Manville, a series of ripple marks are found extending some seventy-five yards where the stratum is unbroken. This series I shall call the Van Buren, since they are found but a short distance from the house of John Van Buren. The trend of crests here is N. 40° E.; wave length, thirty inches; depth of trough one and a half to two and a half inches; thickness of stratum, two to three and a half inches. The approximate vertical distance below the Clinton limestone is 342 feet.

In the creek bed, beneath the bridge across the east fork of Indian Kentucky Creek, and within 200 yards of Manville postoffice, a ripple marked layer of limestone from four to six inches thick is exposed at intervals for a distance of 130 yards. At low water the marks are here exposed over a space of 150x25 feet and as many as sixty consecutive crests may be counted. The trend here is approximately N. 10° E., the wave length thirty inches, the depth of trough two and a half inches, the vertical distance below the Clinton formation 350 feet. At this place the wide exposure, amounting at times to 300 or more square yards, affords an excellent opportunity for the study of the relations which the marks bear

to each other. It is observed that, while the crests are not straight, but more or less curving in their outline, they are essentially parallel.

On Doe Run, about two miles from Brooksburg, a ripple marked limestone is exposed in the creek bed, over a space of a few square yards. The trend of crests here is approximately N. 45° E.; wave length, thirty-three to thirty-six inches; depth of trough, three inches; thickness of limestone, three to five inches. The vertical distance of this series of marks below the Clinton formation could not be determined so readily as in the other cases, since the outcropping Clinton is not found within a distance of several miles. An approximate vertical distance of 380 feet below Clinton was reckoned on the basis of an observed westerly dip of ten feet to the mile of the Clinton formation in other parts of the county.

The main facts in regard to these ripple marks are placed in tabular form below.

These Hudson limestone ripple marks are exceptional in that ripple marks are unusual in limestone, being found in sandstones and shales chiefly. They are exceptional also in the fact that they are of such large size. A few inches usually measures the distance from crest to crest of ripple marks. Since a ripple is a small wave, these limestone markings might well be called wave marks, were that term not preoccupied. These ripple marks indicate essentially seashore conditions during the period occupied in depositing some 300 feet of Hudson rocks and that the conditions finally resulting in the Cincinnati Geanticline or uplift at the close of the Ordovician, had long been present. The trend of these marks from N. 10° E. to N. 75° E., goes far towards indicating prevailing winds from the northwest or the southeast during that part of paleozoic time represented in the deposition of these rocks.

LOCATION.	Trend.	Distance from Crest to Crest.	Depth of Trough.	Vertical Distance below Clinton Limestone.	Thickness of Limestone Stratum.
Upper Wolf Run Series.....	N., 75° E.	21 in.	1½ in.	70 ft.	2-3 in.
Lower Wolf Run Series.....	N., 50° E.	18 in.	1-1½ in.	70 ft. 8 in.	1½-2½ in.
Clifty Creek Series.....	N., 10°-15° E.	30-36 in.	2-3 in.	190 ft.	5-7 in.
Van Buren Series.....	N., 40° E.	30-36 in.	1½-2½ in.	340 ft.	2-3½ in.
Manville Bridge Series.....	N., 10° E.	30 in.	2½-3 in.	352 ft.	4-6 in.
Doe Run Series ...	N., 45° E.	33-36 in.	3 in.	375 ft.	3-5 in.

