DETERMINATION OF DIRECTION OF LATE WISCONSIN ICE MOVEMENT FROM STONE COUNTS IN CARROLL ESKER

SENIOR THESIS--Done in fulfillment of requirement for the Bachelor of Science Degree at Ohio State University

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ABSTRACT

The purpose of this study is to see if the cobble lithology in a Wisconsin Carroll esker would infer direction of ice movement. Roundness was also studied to determine, in a gross fashion, distance of travel of the cobbles. The data shows a high carbonate to clastic ratio with foreign rock (igneous and metamorphic) about equal to clastic. This indicates an ice movement from a west of north direction from the esker. The data also indicates little or no variation in the direction of the ice movement.

PURPOSE OF THE STUDY

The reason for this study was to determine if cobble lithology in an esker could be used to indicate direction of ice movement in Wisconsin time prior to the formation of the esker. This was thought to be feasible because of the location of the esker on the margin of the Allegheny Plateau.

A short distance to the west and northwest of the esker the predominant bedrock type is carbonate, while, in contrast, to the northeast it is predominantly sandstones. It is generally agreed that the debris which comprises eskers is derived from ablation till. It is also accepted that ablation till reflects the bedrock type over which the ice moved.

Assuming the above to be true, a dominance of one rock type over another should indicate a particular direction of movement.

GEOGRAPHIC LOCATION

The esker is situated in Fairfield County about one half mile northwest of Carroll Township and just west of Route 33. It is directly west of the western extension

of the Johnstown Moraine and associated with the kame terrace to the west, north, and northeast as mapped by Jane Forsythe. The esker is completely surrounded by lake silts also mapped by Jane Forsythe.

PROCEDURES

Stone counts were done in a pit excavated for gravel. One hundred cobbles were counted for every foot over a twelve foot vertical interval. The cobbles selected were between an inch and a half (long axis) to five inches. The average size, however, was approximately three inches. These cobbles were taken back to the laboratory, the roundness was noted on each cobble, then the cobble was broken open to produce a fresh surface and the lithology noted. Also, fifty boulders in the esker were counted at random from a pile of boulders discarded by the gravel pit operators. Their lithology and roundness were also noted in the same fashion as the cobbles.

OBSERVATIONS

The cobble counts were done in May 1969, and at that time very little stratification was shown and the sorting

was poor.

In November 1969, the author returned to the gravel pit. The pit had been further excavated that summer, and much more was exposed. On the east facing wall, beautiful crossbedding of sands and gravels was exhibited. There were well sorted sand lenses present as well as graded bedding. The crossbedding indicated a north-south current direction. The general dip of the strata was north, but the magnitude of the dip was not measured. On the west facing wall sorting was poor and stratification was unclear. In the south facing wall there was an interesting collapse feature shown. The Author's conjecture was that it might have resulted from an ice ridge's melting after deposition of the gravels on either side.

FIGURE I

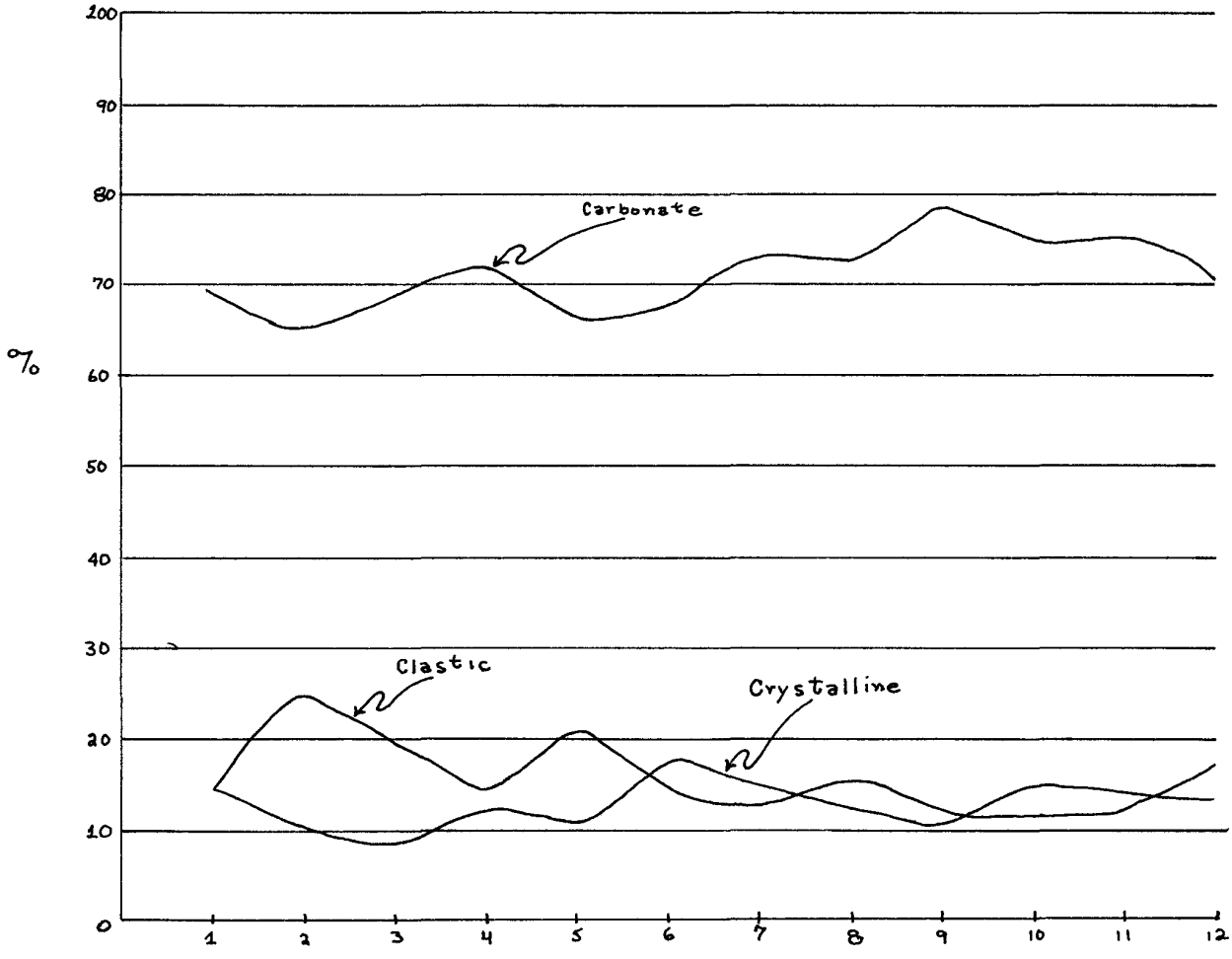
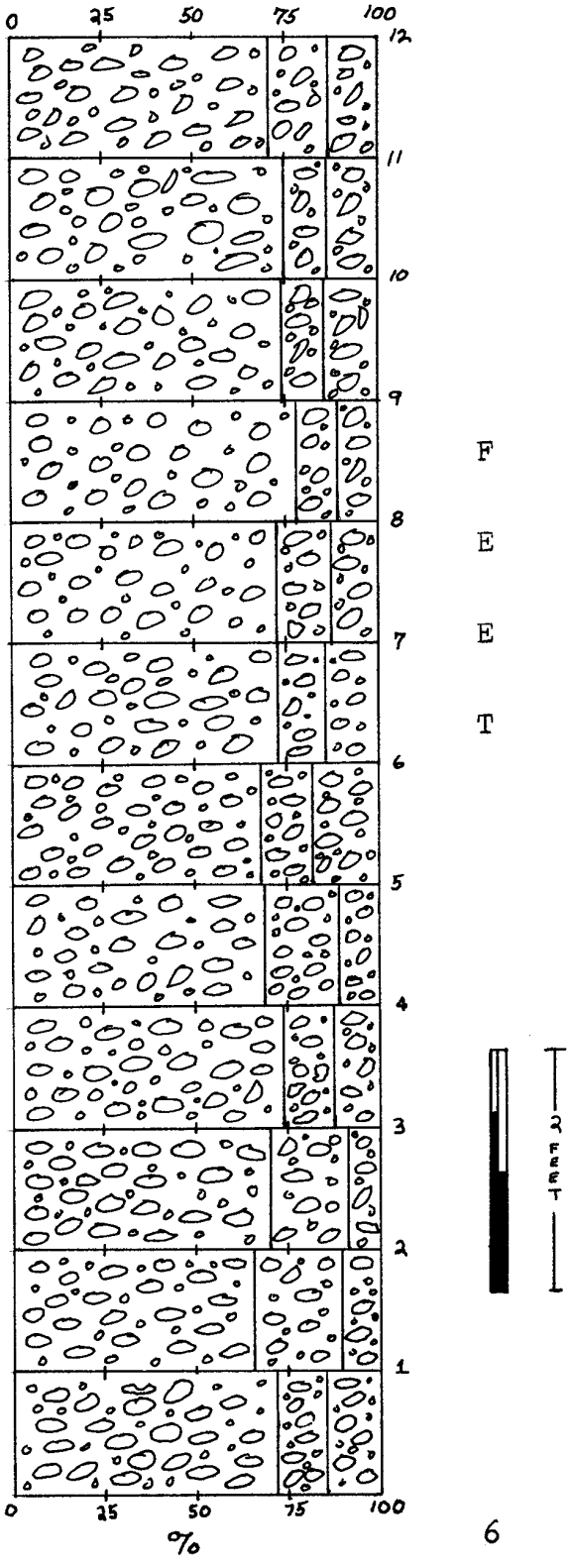
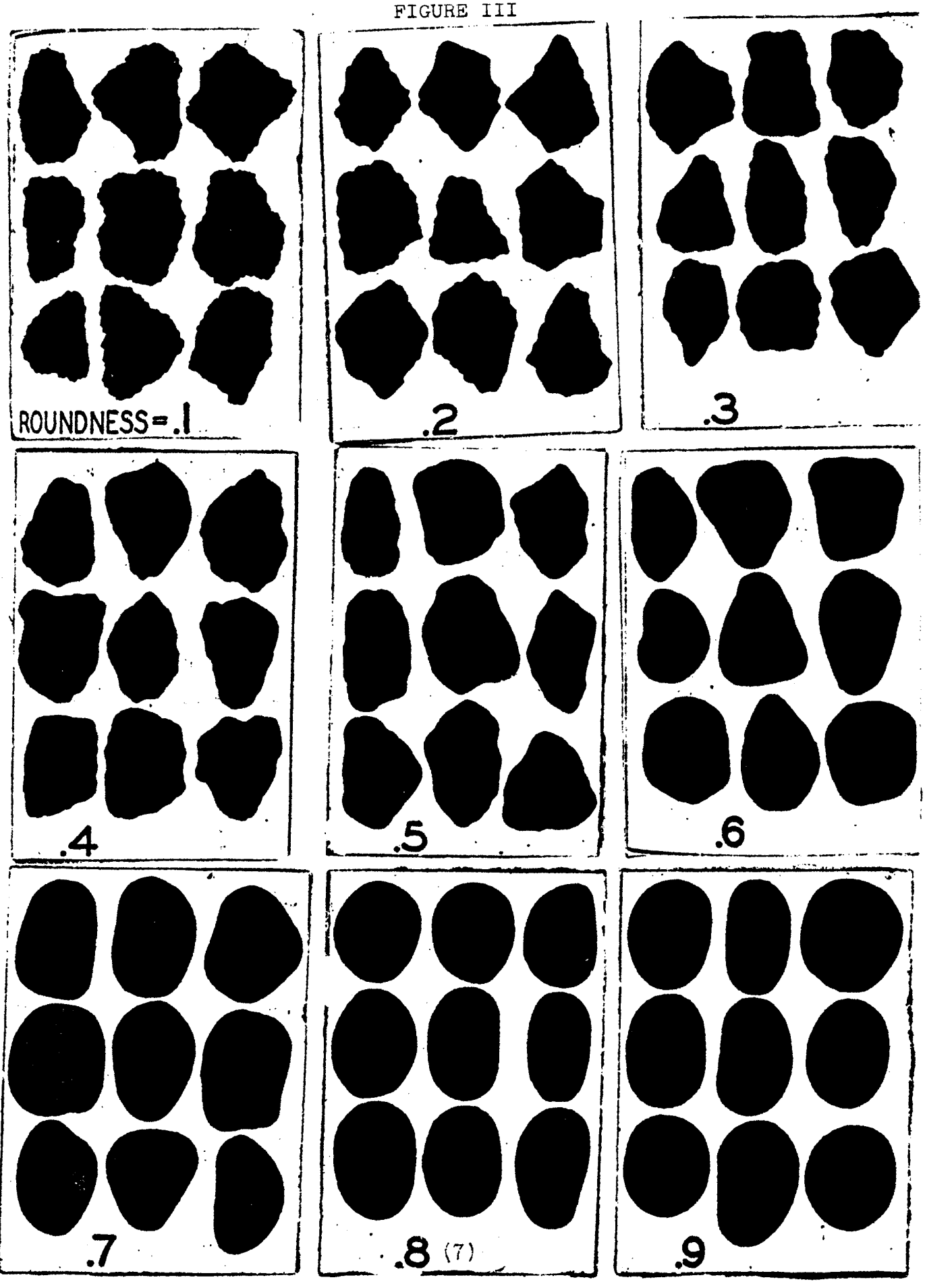

100
90
80
70
60
50
40
30
20
10
0
%
Carbonate
Clastic
Crystalline
1
2
3
4
5
6
7
8
9
10
11
12
INTERVALS

FIGURE II



Relative percentages of carbonate, clastic, and crystalline cobbles as indicated by stone counts over twelve feet vertical section in Carroll esker.

FIGURE III



INTERVAL I

Roundness	Crystallines*	Clastics	Carbonates
.1	0	0	0
.2	0	0	0
.3	1	0	0
.4	0	0	1
.5	4	1	8
.6	6	6	37
.7	1	5	12
.8	0	0	3
.9	0	0	0

* Crystalline includes igneous and metamorphic rocks

INTERVAL II

Roundness	Crystallines*	Clastics	Carbonates
.1	0	0	0
.2	0	0	0
.3	0	0	0
.4	0	0	2
.5	2	3	10
.6	5	6	21
.7	0	2	10
.8	0	6	1
.9	0	1	0

* Crystalline includes igneous and metamorphic rocks

INTERVAL III

Roundness	Crystallines*	Clastics	Carbonates
.1	0	0	0
.2	0	0	0
.3	0	0	0
.4	0	0	0
.5	1	0	14
.6	5	6	39
.7	1	10	10
.8	1	3	4
.9	0	0	0

* Crystalline includes igneous and metamorphic rocks

INTERVAL IV

Roundness	Crystallines*	Clastics	Carbonates
.1	0	0	0
.2	0	0	0
.3	0	0	0
.4	0	0	0
.5	4	0	6
.6	6	7	34
.7	1	3	22
.8	0	1	6
.9	0	2	0

* Crystalline includes igneous and metamorphic rocks

INTERVAL V

Roundness	Crystallines*	Clastics	Carbonates
.1	0	0	0
.2	0	0	0
.3	0	0	0
.4	0	0	0
.5	2	1	7
.6	6	7	36
.7	2	11	22
.8	0	1	1
.9	0	0	0

* Crystalline includes igneous and metamorphic rocks

INTERVAL VI

Roundness	Crystallines*	Clastics	Carbonates
.1	0	0	0
.2	0	0	0
.3	0	0	0
.4	0	0	2
.5	5	1	10
.6	8	2	28
.7	2	8	16
.8	1	2	4
.9	0	0	0

* Crystalline includes igneous and metamorphic rocks

INTERVAL VII

Roundness	Crystallines*	Clastics	Carbonates
.1	0	0	0
.2	0	0	0
.3	0	0	0
.4	0	0	0
.5	6	2	15
.6	7	3	45
.7	0	5	9
.8	1	2	1
.9	0	0	0

* Crystalline includes igneous and metamorphic rocks

INTERVAL VIII

Roundness	Crystallines*	Clastics	Carbonates
.1	0	0	0
.2	0	0	0
.3	0	0	0
.4	0	0	0
.5	3	2	15
.6	6	8	39
.7	3	3	16
.8	0	2	0
.9	0	0	0

* Crystalline includes igneous and metamorphic rocks

INTERVAL IX

Roundness	Crystallines*	Clastics	Carbonates
.1	0	0	0
.2	0	0	0
.3	0	0	0
.4	0	0	1
.5	3	2	10
.6	3	4	51
.7	4	3	12
.8	0	2	2
.9	0	0	0

* Crystalline includes igneous and metamorphic rocks

INTERVAL X

Roundness	Crystallines*	Clastics	Carbonates
.1	0	0	0
.2	0	0	0
.3	0	0	0
.4	0	0	1
.5	9	3	16
.6	3	4	40
.7	1	4	14
.8	1	0	2
.9	0	0	0

* Crystalline includes igneous and metamorphic rocks

INTERVAL XI

Roundness	Crystallines*	Clastics	Carbonates
.1	0	0	0
.2	0	0	0
.3	0	0	1
.4	0	0	4
.5	8	1	8
.6	4	4	44
.7	1	2	18
.8	1	3	1
.9	0	2	0

* Crystalline includes igneous and metamorphic rocks

INTERVAL XII

Roundness	Crystallines*	Clastics	Carbonates
.1	0	0	0
.2	0	0	0
.3	0	0	0
.4	0	0	0
.5	3	1	6
.6	8	8	35
.7	0	3	15
.8	0	1	3
.9	0	1	0

* Crystalline includes igneous and metamorphic rocks

RANDOM BOULDERS

Roundness	Crystallines*	Clastics	Carbonates
.1	0	0	0
.2	0	0	0
.3	0	0	0
.4	0	0	6
.5	5	7	5
.6	12	3	7
.7	0	4	0
.8	0	1	0
.9	0	0	0

* Crystalline includes igneous and metamorphic rocks

View looking north-northwest in Carroll esker.

RESULTS OF THE COBBLE COUNTS

The predominant rock type was carbonate averaging around 70% over the twelve foot vertical interval as shown by Figure I and Figure II. There was little variation over the interval with the smallest percentage of 65.5% at two feet above the base and the highest percentage of 78.5% at nine feet above the base. At the base the percentage was 69.5%, and at the top it was 70.5%. The clastic percentage ran on the average a little higher than the foreign rock. The average for clastic was around 18% and about 12% for foreign.

The percentages of each rock type was much more nearly equal for the boulders than for the cobbles. Carbonate boulder's percentage was 36% to 30% for clastics and 34% for foreign.

The roundness was predominantly six(.6) according to Figure III (roundness chart). There were no cobbles more angular than three; however, there were cobbles as round as nine(.9).

PREVIOUS WORK USED IN THIS STUDY

Jane Forsythe mapped the glacial geology of Fairfield

County and illustrated the Carroll esker in which the author's study was made. Jane Forsythe's work in this area was done before the esker was excavated, and her conjecture regarding the esker's composition was very accurate.

The study done by Richard P. Goldthwait on Wisconsin glaciation was very informative to the author and led to some insight into the nature of the ice sheet which deposited the esker and surrounding glacial forms.

George F. Hanson's laboratory study on the origin of eskers was also helpful. His conclusion that at least some eskers can be formed by subglacial and superglacial meltwater streams discharging into a glacial debris dammed pond at the margin of a glacier seems to fit the situation of the Carroll esker.

SUMMARY AND CONCLUSIONS

The esker appears to have formed in a glacial lake or pond, as evidenced by the presence of the surrounding silts, as the glacier retreated. This is also supported by the adjacent Johnstown Moraine and the kame terrace. The presence of crossbedding and sand lenses indicate a fairly substantial current during deposition.

The predominance of carbonate lithology indicates

that the ice moved from a northwesterly direction, and its constancy throughout the section shows there was little variation in the direction of ice movement.

Ablation till is made up predominantly of angular debris, and the debris is thought to be mostly of local origin, although obviously not all of it is local. The roundness of the cobbles indicates that the carbonate and clastic cobbles were transported on the order of a few miles, probably within ten miles, in the meltwater stream to attain their degree of roundness. The foreign rock was obviously derived from a great distance away from Carroll, Ohio, probably somewhere in Canada.

From the above assumptions it should be concluded that the carbonates were derived from bedrock within a few tens of miles from Carroll, Ohio. The chert found in the debris and cherty limestone would make one suspect that some of the carbonates were derived from the Delaware limestone which contains frequent chert stringers in some areas. However, there are other sources of chert, and the origin was not proven by the author.

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ACKNOWLEDGMENT

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