

**THE TRENTON GRAVEL AND ITS RELATION TO THE ANTIQUITY OF MAN.**

BY HENRY CARVILL LEWIS.

In the course of an investigation of the Surface Geology of Southeastern Pennsylvania, some facts have been developed in connection with one of the gravels, which, bearing directly upon the Antiquity of Man in America, become of great interest. Among the many scientific problems now attracting attention, none perhaps holds a more prominent position than that of the Antiquity of Man. It is a subject which, notwithstanding the numerous facts gathered and the bulk of literature published, must be regarded as still in an undecided condition.

As the Delaware is in many respects a typical river, and as therefore deductions made here will hold good for the valleys of many other rivers of the Atlantic coast, it is thought that a record of the investigation will be of more than mere local interest. The subject will be approached from a purely geological standpoint. The main difficulty in inquiries of this kind has been the absence of exact geological data. Hasty conclusions have been drawn from an inspection of relics found in a gravel, which a more accurate knowledge of the age of that gravel would not have sustained.

The writer has shown in former papers<sup>1</sup> that the gravels of the Delaware Valley belong to several distinct ages; and if therefore at any place the remains of man are shown to occur, it will be all important to know to which of these gravels they should be referred.

The surface formations of Southeastern Pennsylvania may be divided into five clays and four gravels. The following is believed to be the succession in which they occur, beginning at the oldest: (1) Jurasso-Cretaceous plastic clay; (2) Tertiary clays, ("Brandon Period"); (3) Bryn Mawr gravel, (upper Tertiary); (4) Branchtown clay; (5) Glassboro gravel, (Pliocene); (6) Philadelphia red gravel, (Champlain); (7) Philadelphia brick-clay, (Champlain); (8) Trenton gravel, ("Eskimo period"); (9) Recent alluvium. Of clays, the oldest is the Jurasso-Cretaceous plastic clay exposed at Turkey Hill, Bucks Co. A similar plastic clay,

<sup>1</sup> "The Surface Geology of Phila. and vicinity." Proc. Min. and Geol. Section, Acad. Nat. Sc. Phila., Nov. 1878.



which, however, may be of later age, has been passed through by artesian wells in the southern part of Philadelphia. The next oldest clay appears to be the potters' clay of the Montgomery Co. limestone valley, which, containing sometimes lignite, and overlaid by kaolin, decomposed hydromica slate, etc., belongs with its associated limonite ores, to an inland Tertiary formation, the "Brandon Period," possibly of Oligocene age.<sup>1</sup> A third clay, the "Branchtown clay," found at high elevations in a few places in the gneissic region, containing occasional boulders, was made at a period of general submergence and appears to be of a late Tertiary age. The "Philadelphia brick-clay" of more recent formation, of large extent, and with numerous boulders, is confined to the river valley. This clay, deposited at the close of the Glacial period by the waters resulting from the melting of the great Northern Glacier, rests against the rocky "upland terrace" at a height of about 150 feet above the present river. The fifth and newest clay is the recent bog clay or mud in the flood-plain of the river, still in process of formation.

The gravels are distinguished from one another both by their composition and by their relative hypsometrical positions. The "Bryn Mawr gravel"—the oldest gravel of consequence in this region—is readily distinguished from others by the peculiar materials composing it, and is also known by being found at high elevations (400 feet), in often isolated patches, capping the gneissic hills. It is characterized by absence of fossiliferous or Triassic pebbles and by the presence of an iron conglomerate, and is of oceanic origin, and probably upper Tertiary age.<sup>2</sup> A similar gravel occurs on the heights of Georgetown, D. C. The next oldest gravel, also oceanic, and which here occurs at lower elevations than the last, the writer called in a former paper "The Fossiliferous Gravel." It frequently contains pebbles formed of Niagara limestone and other fossiliferous rocks, and has been found abundantly in New Jersey as well as in Pennsylvania. It is well exposed in the railroad cut at Ridley Park, Del. Co. It is the yellow gravel which caps the watershed between the Atlantic and the Delaware at a height of nearly 200 feet, and is now named for distinction "The Glassboro gravel." Its pebbles are frequently

<sup>1</sup> V. "The Iron Ores and Lignite of the Montgomery Co. Valley," by the writer. Oct., 1879.

<sup>2</sup> V. "On the Bryn Mawr Gravel," by the writer, Mar., 1879.



weather-worn and eaten by age, and have thus a much more ancient appearance than the smooth, fresh-looking pebbles of later gravels. It contains no boulders of consequence and is believed to be of Pliocene age.

Lying at a lower level, within the Glassboro gravel, and formed of a mixture of its pebbles with others brought down the Delaware valley, is a third gravel—the “Philadelphia red gravel.” This, like its overlying brick-clay, is confined to the river valley. It is distinctly stratified; it contains numerous fragments of Triassic red shale and of gneiss, and smooth boulders of Silurian rocks; it shows flow and plunge structure and wave action on a large scale; and like the older gravels, it rests upon a decomposed gneiss, which is sometimes interstratified with its lower layers. There are numerous exposures near the University of Pennsylvania. The writer has identified it on the Potomac and other rivers, and it appears to belong to the age of the melting glacier—the Champlain epoch.

The last and newest of all the gravels is one which, at Philadelphia, seemed to be of little importance. It lies close along the river, and rising a few feet above it, extends but a short distance back from the river bank. It covers the flat ground of Camden and the lower part of Philadelphia, and forms islands in the river. It was called *The River gravel and sand*. It is this alluvial gravel, the latest, except the recent mud-flats, of all the surface formations, which is the subject of the present paper, and which, from its great development farther up the river, is now named *The Trenton Gravel*. It is in this gravel, and in this gravel only, that traces of man have been found.

The Trenton Gravel at Philadelphia is composed principally of a sharp micaceous sand, which, when below water-level, becomes a “quicksand.” Gravel lies below the sand. Unlike all the other gravels, it contains but few pebbles of white quartz, and is of a dark gray color. Its pebbles are made exclusively of the rocks forming the upper valley of the river. Their shape is also very characteristic. The pebbles of the older gravels are oval or egg-shaped, but these are for the most part flat. This flat shape is characteristic of all true river gravels. At several places along the Delaware, gold has been obtained from this gravel. The absence of clay in any of its layers indicates the action of swiftly-running water. Data obtained from artesian wells have shown



that this formation has a depth on Delaware Avenue, Philadelphia, of about 50 feet, and that it extends up to about Third and Market Streets. On Smith's Island and on the bar in the river opposite Cooper's Point, it is 100 feet deep, lying upon rock. It therefore underlies the river, filling up its ancient channel. On Richmond Street some very large boulders are seen lying upon the sand.

On tracing the Trenton gravel up the river, it is found to be confined to its immediate vicinity, and that, from Philadelphia to the Neshaminy Creek, its boundary is generally between the line of the Pennsylvania Railroad and the Delaware. From this point the bounding terrace trends directly towards Morrisville and away from the present river. Thus, at Bristol, the gravel and its overlying sand extends two miles back from the river, and is bounded by a well-marked hill, upon which lie the older gravel and brick-clay of Champlain age. These and the Tertiary gravels extend nearly seven miles inland. At Tullytown the Trenton gravel extends two and a-half miles back, and at the canal shows the following succession of strata: (1) sandy loam, 1 foot; (2) fine gray "moulding-sand,"  $2\frac{1}{2}$  feet; (3) sharp "bar sand," 1 foot; (4) clean gray river gravel of unknown depth. In other openings near here the gravel is so full of boulders that these are dug in large quantities and sent to Philadelphia for "cobble-stones." Near Wheatsheaf Station, close to the railroad, an opening which has exposed a section of the Trenton gravel nearly half a mile in length, exhibits well the general features of the formation. The pebbles, of characteristic shape and color, are made of gray Triassic argillite, slate, red shale, sandstone, conglomerate, and various other rocks found farther up the valley, while large and often sharp boulders of red shale and other materials frequently occur. The whole formation has a very fresh appearance when compared with older gravels. Near Turkey Hill a large smooth boulder, five feet in diameter, lies upon the sand.

At Morrisville the narrower portion of the valley begins, and from here up, the river flows on a rocky bottom, and the gravel is shallow and is confined to the immediate vicinity of the river. The older gravels of oceanic origin continue across New Jersey and do not appear above Yardleyville. The Philadelphia red gravel is no more seen, but the brick clay with its boulders occasionally appears part way up the steep hills enclosing the valley, and is abundant in the side valleys formed by tributary streams.



Above Yardleyville, therefore, we have to deal with but two surface formations,—the boulder-bearing brick clay, often much eroded, and the Trenton gravel, confined to the bottom of the valley and showing but little erosion. It will be well to bear in mind the distinction between these two formations,—the one of glacial, the other of post-glacial age. The writer has traced them as far up as the Water Gap, past the great terminal moraine into glaciated regions. It is interesting to note that while the modified moraine material close to the river at Belvidere is in some points similar to the Trenton gravel, and is the source of part of that formation, the moraine on the Lehigh River at Stemton and at other inland localities contains pebbles and boulders very similar to those of the Philadelphia brick-clay.

Throughout the whole course of the Trenton gravel it is observed that it lies within a channel previously excavated down to the rock through the boulder-bearing brick clay and its red gravel, which, as shown in a former paper, belong to the Champlain epoch. The Trenton gravel is therefore, later than the Glacial and Champlain epochs; and this is a fact which, when considered in connection with the human relics found in this gravel and the consequent antiquity of man, it will be most important to remember.

Having now sketched the character and position of the Trenton gravel along the Delaware valley, we are prepared to examine the formation as exposed at the locality whose name we have chosen to distinguish it.

Trenton is in a position where naturally the largest amount of a river gravel would be deposited, and where its best exposures would be exhibited. It is at the point where a long, narrow valley with precipitous banks and continuous downward slope, opens out into a wide alluvial plain at a lower level. It is here that the rocky floor of the river suddenly descends to ocean level and even sinks below it, forming the limit of tidewater. Thus any drift material which the flooded river swept down its channel would here, upon meeting tidewater, be in great part deposited. Large boulders which had been rolled down the inclined floor of the upper valley would here stop in their course, and all be heaped up with the coarser gravel by the more slowly flowing water except such few as cakes of floating ice could carry oceanward. On the other hand the finer gravel and sand would be deposited farther down the river.



This is precisely what occurs at Trenton. The material, which at Philadelphia is generally fine, grows coarser as the river is ascended, until at Trenton we find often immense boulders imbedded at all angles in the gravel. Moreover, the river has here cut entirely through the gravel down to the rock, exposing at one place a cliff of gravel 50 feet high. At Philadelphia, on the other hand, as we have seen, the river still flows on the top of the gravel. This fact may also be accounted for. Having heaped up a mass of detritus in the old river channel as an obstruction at the mouth of the gorge, the river, so soon as its volume diminished, would immediately begin wearing away a new channel for itself down to ocean level. This would be readily accomplished through the loose material, and would be stopped only when rock was reached. On the other hand, that gravel which had been deposited at places farther down the river where its bottom was below ocean level, would remain un-eroded or nearly so. When the river had attained the level of the ocean there would be no occasion to cut a deep channel, and it would therefore flow on top of the gravel which it had deposited. It is necessary that this point should be understood, as other geologists have brought forward various theories to explain the high bank of gravel at Trenton. The fact of the river having cut through the gravel at Trenton, while at Philadelphia it flows upon it, is due to the configuration of the rock floor of the river, which at Trenton rises above ocean level, and at Philadelphia lies nearly 100 feet below it.

In addition to the exposure upon the river bank, where the whole depth of the formation is seen, the long railroad cuts made by the Pennsylvania R. R. at Trenton, afford excellent sections of the gravel. It exhibits the distinctive characteristics of a true river deposit, and is very different from the gravels which are found at higher levels. It contains no clay; its pebbles are made of the rocks of the river bed and are flattened, and the stratification of the whole deposit is well seen in the alternations of sand and gravel. It extends several miles back from the present river, covering the low ground along the Assunpink Creek, and indicating the existence here of a former bay or arm of the Delaware. This bay was shaped somewhat like a horseshoe, which had one extremity in Trenton at the hill above the canal, and which washed the base of the hill north of the Assunpink Creek, and, extending about three miles back from Trenton, and sweeping



around the "Bear Swamp," had its other extremity near the house of Dr. C. C. Abbott, below Chambersburg. This village was under water. Another bay extended up the valley of Crosswicks Creek. Boulders of Champlain age lie upon the Tertiary gravels which form the ancient bank.

From the extent of the Trenton gravel in this vicinity, statements have been published that it covered the whole southern part of the state, and that at the time of its deposition the Delaware River emptied into the ocean at Trenton. It is evident that the distinction between the very different gravels of this region has not been perceived. Careful examination will show the great dissimilarity between the Trenton gravel and such gravels as occur at Princeton Junction and interior New Jersey, which are in great part of Pliocene age, and will prove that it is confined to the ancient river bed.

The presence of very large boulders on the river bank at Trenton has led some geologists to suppose that the formation was a glacial moraine. The occasional though very rare examples of scratched pebbles and polished boulders, which the flood had evidently carried down from the moraine material north of Belvidere, have been brought forward as supporting this theory. Yet the absence of till and of angular masses of rock, and generally of materials foreign to the Delaware Valley, when regarded in connection with what we have shown to be the general characters of the formation, can not be explained upon this theory. The character of the river banks along the valley render the presence of a glacier at Trenton extremely improbable. These show no marks of glacial action. We have, moreover, already shown that the Trenton gravel is more recent than the deposits of Champlain age, and that, lying in a channel cut within them, it is the most recent of all the gravels. Clearly the Delaware Valley and the channel of the river were excavated in a time previous to the deposition of the Trenton gravel. The channel subsequently having been filled up by this gravel, the diminished river still later has cut a new channel either completely through it, as at Trenton, or partially, as at Philadelphia. It is probable that slight undulations of the level of the coast have aided in producing these changes.

Before describing the human relics found in the Trenton gravel, there are several facts bearing upon its origin and age which it will be well to consider.



It has been noticed that from Trenton to Philadelphia the creeks flowing into the river Delaware have a steep south bank, while the ground north of the creek is flat. The writer finds that the flat ground north of the creek is made of Trenton gravel, while the southern bank is made of older formations which have been formerly cut away by water action coming from the north. Thus, the steep south bank of the Neshaminy is made of "Philadelphia red gravel" of Champlain age, while a flat plain of Trenton gravel lies south of the creek. The same configuration of the banks of creeks on the New Jersey shore has been noticed by Prof. Cook. By assuming that the river at the time of the deposition of this gravel was of larger volume than now, this fact is of ready explanation. The southern bank of the creek, often of Cretaceous or Tertiary strata, in each case formed the shore of the ancient river, and was worn away into a steep bank by the flood from the north. Similar in cause and effect are the present banks of the Delaware, which are steep on the outside of each curve of the river, and flat and covered with recent alluvium on the inside.

Another fact showing river action is the frequent occurrence of exposures of "flow and plunge structure" in this gravel. In these the layers are seen to dip up stream, as would be expected by downward flowing water. It is interesting to find, on the other hand, that the same structure in the Tertiary gravels, both of Pennsylvania and New Jersey, shows layers dipping southeast, as though deposited by incoming oceanic tides.

Another instance of the fluvial character of the Trenton gravel is found in the peculiar topography which it sometimes exhibits. Frequently, instead of forming a flat plain, it forms higher ground close to the present river channel than it does near its ancient bank. Moreover, not only does the ground thus slope downward on retreating from the river, but the boulders become smaller and less abundant. Both of these facts are in accordance with the laws of river deposits. In a time of flood the rapidly flowing water in the main channel, bearing detritus, is checked by the more quiet waters at the side of the river, and is forced to deposit its gravel and boulders as a kind of bank.

In determining the comparative age of the Trenton gravel, a guide may be found in the amount of its erosion. In this respect a marked contrast exists between this and more ancient gravels. Unlike the land covered by older surface formations, that covered



by the Trenton gravel is remarkably level and free from hillocks or ravines. The change in topography may be well seen in the neighborhood of Trenton, and can be noticed almost anywhere along the valley. This fact alone would indicate a more recent age than that of the clays and gravels of the Champlain epoch. This difference is much more marked when comparison is made with the oceanic gravels.

The actual time necessary for the Delaware to cut down to the rock through 50 feet of this gravel at Trenton is by no means great. Numerous facts have been adduced by geological writers and by engineers to show how rapidly a stream of water can wear through loose gravel material. When it is noted that the gravel cliff at Trenton has been made, not by a straight downward cut, but by a side wearing away as at a bank, and when it is remembered that the erosive power of the Delaware was formerly very much greater than it is now, it will be conceded that the presence of the cliff at Trenton will not necessarily infer its high antiquity. From what is known of the action of running water upon gravel, it is thought that the time necessary to produce the erosion now observed might be reckoned by hundreds rather than by thousands of years. While the gravel was of course formed in a previous time, the rapid action of the flood which deposited it, shown in many places by the character of the gravel, indicates that the time necessary for its deposition need not have been long.

Having now shown that the Trenton gravel is a true river deposit of modern age, it will be of interest to inquire how such a flood as we have proved to exist could have originated. No flood within the historical epoch has been known to at all approach in magnitude that which deposited the Trenton gravel. No boulders of the size found in and upon that gravel are ever carried down the river by recent ice-cakes. In fact, at Trenton and below, the boulders of this gravel are often much larger than any in the Champlain gravel of that part of the valley.

We have seen that at the time of the Trenton gravel flood, the lower part of Philadelphia, the whole of Bristol and Tullytown, and almost all of Trenton were submerged. That the climate was then cold is indicated not only by the suggestion that there were then probably very large masses of boulder-bearing ice floating in the river, but also by the fact that, as the writer is informed by Dr. C. C. Abbott, bones of Arctic animals (walrus, reindeer, mastodon),



often rounded by attrition, have been found in this gravel. Although the Trenton gravel has none of the features of a moraine, it is true that the cliff at the base of Riverview Cemetery, holding immense boulders, has the appearance of having been deposited by glacial waters. At other places, the boulders resting upon the sand overlying the gravel suggests the grounding of large ice-cakes derived from some mass of ice large enough to be called a glacier.

It is difficult to imagine an origin for such a flood as we have described other than the melting of a glacier. We have shown that the flood was not an inroad from the sea, but that it came down the valley. No rain-storms of modern experience could have supplied such an amount of water. To call the time of this flood a "Pluvial Epoch," will be of little assistance, since no origin for such extraordinary rains is suggested, except under a very different climate, or by evaporation from a melting glacier.

Yet such a glacier cannot be the great glacier of the Glacial epoch. That was the glacier which in its melting deposited the brick-clay and red gravel which we have shown to be much older than the Trenton gravel. It must have been, if a glacier at all, another and more recent one whose melting caused the flood which formed this gravel. This last glacial flood flowed in a channel excavated through the deposits of the first glacial period.

It appears, then, that there is evidence of a *Second Glacial Period*—a period in which was deposited the last of the gravels, and which has but lately passed away. From the limited extent of its deposits it is inferred that the second glacier was much smaller than the first, and that its southern extremity was confined to the valley. A second glacial period is recognized in Europe under the name of the *Reindeer Period*.

It is thought that the hypothesis of a second and more local glacier, long subsequent in age to the first great glacier, will explain all the facts observed. The Trenton gravel cannot be assigned to the first glacial period except by assuming that there have been no river gravels deposited since that time;—an assumption which can hardly be maintained. Some European archaeologists have held that the *Palæolithic Era*, the era of the river gravels, is antecedent to the *Reindeer Period*, the period of the cave-men. No such distinction has been observed on the Delaware. Should future researches show that a separate and second glacial



epoch cannot be proved in America, the facts here observed will indicate a much more recent date for the disappearance of the great glacier than has been assigned to it. The period of the Trenton gravel flood, whether contemporaneous with a glacier or not, is the period of the last geological deposits here known; the recent mud-flats being alone excepted.

We have now glanced at the characters of the Trenton gravel, and have indicated, so far as the facts at hand allow, its position, origin, and relative age.

It is in this gravel that the writer's friend, Dr. Charles C. Abbott, of Trenton, has made the interesting discovery of stone implements of human workmanship, which, in their shape and characters, are quite unlike those of the Red Indians of the Atlantic coast.<sup>1</sup> He has found them imbedded at various depths in the apparently undisturbed gravel of the cliff at Riverview Cemetery and in other places near Trenton. They are of palæolithic type, and differ from Indian stone implements by being larger, ruder, and made from a different material. They are composed of gray argillite, a rock which is found in place farther up the river, and which is a Triassic shale altered and hardened by the heat from adjacent trap dykes. They occur in positions which render it extremely probable that they belong to the same age as that of the deposition of the gravel, or at least to an age when it was overflowed by the flooded river. There are two points which offer strong evidence in that direction.

The first is the fact that modern Indian implements, "neoliths," are never found associated with these "palæoliths" in the gravel. Although abundant on the surface, it is stated that they never occur at a depth of more than a few inches in undisturbed soil, while the palæoliths are found often ten or more feet from the surface. This fact alone argues a different age for the two classes of implements.

The second fact is that when found below the surface of the ground, these palæoliths always occur in the Trenton gravel and never in older gravels. The writer, in company with Dr. Abbott, has gone over much of the ground where the implements occurred; and it was very interesting to find that it was only within the limits of the Trenton gravel, previously traced out by the writer,

<sup>1</sup> V. Tenth and Eleventh Annual Reports of the Peabody Museum of American Archæology.



that Dr. Abbott had found implements below the surface. Beyond the terrace of older gravels the palæoliths sometimes occur with implements of the modern type, but are not imbedded at any depth. In Pennsylvania, moreover, the writer has found similar palæoliths in the region covered by the Trenton gravel and in that region only. Here, then, is the strongest probability, even if the implements were found upon the surface only, that they belonged to and were of coeval deposition with the river gravel.

The implements of argillite found at the lowest depth in undisturbed gravel have been generally decided by archæologists to be of human origin. It is, however, true that there are many sharp fragments of this rock in the Trenton gravel which are of natural origin, and that pebbles and partially rounded fragments of the same rock are frequent. The writer has found several fragments of argillite in the gravel exposed at the cut near Wheatsheaf Station, Bucks Co., Pa., which, whether they were artificial or natural, it was impossible to determine.

All the evidence that has been gathered points to the conclusion that at the time of the Trenton gravel flood, man in a rude state lived upon the banks of the ancient Delaware. He may have been in the habit of spearing fish and seals with spears pointed by his rough stone implements, and these having been dropped into the flood may have sunk into the loose and shifting gravel. The weathering upon the implements is so slight as to afford no evidence of their high antiquity. Many of the palæoliths found in the river gravels of Europe, are of very similar type. As a rule, probably the implements of the Trenton gravel are somewhat more rude. The writer is informed that even more primitive forms are now in constant use among some of our Western Indian tribes.

It is interesting to find, as pointed out by archæologists, that until lately the Eskimos have used stone implements quite as rude and similar in appearance to those found in the Trenton and other river gravels, and it has been suggested that that race, now living in a climate and under conditions perhaps similar to those once existing on the Delaware, may have some kinship with the pre-Indian people of this river. It may be that an Eskimo race, living here at the time of the flooded Delaware, were driven north by the coming of the Red Indians. If future archæological work shows this surmise to be correct, the writer suggests that the period of the Trenton gravel and of this palæolithic people,—a period



perhaps following a second glacial age,—might appropriately be called *The Eskimo Period*. This name, derived from a higher order of beings than that which gave the name *Reindeer Period*, is much more suggestive and is probably of fully as wide application as the latter name. A term already in use, the *Palæolithic Era*, is also convenient.

It has been held that the occurrence of palæoliths at Trenton offered evidence of a very high antiquity of man in America, and, the gravel being considered as a glacial moraine, that man's existence was carried back to interglacial and even preglacial times.<sup>1</sup> As we have seen, the geological investigations along the Delaware Valley, described in this paper, throw quite a new light upon this subject. They show that the implement-bearing gravel is of post-glacial age, and is a river deposit of comparatively recent formation; and that neither in the gravels of the Champlain epoch nor in deposits of any previous age have any traces of man been discovered. The evidence appears to indicate the origin of man at a time which, geologically considered at least, is recent.

The actual age of the Trenton gravel, and the consequent date to which the antiquity of man on the Delaware should be assigned, is a question which geological data alone are insufficient to solve. The only clue, and that a most unsatisfactory one, is afforded by calculations based upon the amount of erosion. This, like all geological considerations, is relative rather than absolute. The same reasoning that showed that the modern river channel might have been excavated in hundreds rather than thousands of years, will indicate that no great length of time is necessary to produce all the surface features of the Trenton gravel. While the writer may venture to express the opinion that there is no reason geologically for carrying the age of this gravel and the antiquity of man on the Delaware farther back than a very few thousand years at the most, he is fully aware that any close approximation can safely be arrived at only by extended comparison with other river gravels and by a much more complete series of observations than have yet been possible. Ethnological considerations, which make palæolithic man to antedate the oldest races of the mound-builders, will have a bearing upon this question. Meteorologists may show that

<sup>1</sup> It will be remembered that Sir Charles Lyell, in his *Principles of Geology*, 11th Ed., vol. 1, p. 286, conjectures the period of the great glacier to have been about 200,000 years ago.



a cold climate and a period of a flood far larger than any of late experience may require a long lapse of time. These considerations are not within the scope of this paper. It has been the aim of the writer to define the antiquity of man in relation to geological rather than to historical events. If, in showing that the Eskimo period is the last of the geological ages, it does not necessarily follow that it is by any means recent, it must be remembered, on the other hand, that its high antiquity is not proven by the facts thus far observed.

The conclusions to which the facts seem to point may briefly be summarized as follows :—

1. That the Trenton gravel, the only gravel in which implements occur, is a true river deposit of post-glacial age, and the most recent of all the gravels of the Delaware valley.
2. That the palæoliths found in it really belong to and are a part of the gravel, and that they indicate the existence of man in a rude state at a time when the flooded river flowed on top of this gravel.
3. That the data obtained do not necessarily prove, geologically considered, an extreme antiquity of man in Eastern America.





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