THE AGE OF THE HUMAN RACE IN THE LIGHT OF GEOLOGY[1]

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[With 3 plates]

There is perhaps no problem upon which we find more divergence of opinion than upon this one of the age of the human race. Between those who still adhere to an age of 6,000 or 8,000 years, as was assumed by the older Biblical exegesis, and those who are exceedingly liberal even with millions, we find all possible shades of opinion. Thus it is impossible for a nonspecialist to find his way through this tohu vabohu and to form a clear judgment. In consequence many have only ridicule for all endeavors to give even approximate figures. The disagreement even amongst the greatest authorities seems to them to show that we can accomplish nothing toward the solution of this problem. However, the situation is not so bad as that, and although there are many uncertainties which prevent the determination of exact figures and which are the cause of the discrepancies among scientists, at least a minimum age can be assigned to mankind. In the following pages an attempt has been made to derive such a minimum from the geologic facts and to show that the age of mankind can not be less than a certain number of millenniums, although it may of course be higher.

MAN IN THE GEOLOGIC TIME SCALE

It is impossible to express the age of mankind in the usual measure of years, unless we know the position of man in the geologic time scale; that is, the relative age of the human race must be found out in terms familiar to geologists. In what geologic period did man arrive on earth? To be more exact: In what geologic period do we find the first unmistakable indications of man's presence?

It is, first, an established fact that man was witness of the glaciation in northern and central Europe. His tools and weapons and his

[1] Reprinted by permission, with author's revision, from publications of the Catholic Anthropological Conference, vol. 1, No. 2, March, 1929.

skeletal remains are found in association with the remains of animals and plants of this cold epoch, in such a way as to demonstrate that man was a contemporary of these animals and plants, as, e. g., the woolly mammoth, the woolly rhinoceros, the reindeer as far south as northern Spain. Man utilized the ivory of the mammoth and the antlers of the reindeer for the manufacture of his implements. He painted these animals on the walls of his caves and engraved them on his tools. Plants of the arctic tundra are found in the deposits of the habitations of man, and shells of clams belonging to the arctic zone—*Pecten islandicus* and *Cyprina islandica*—show that the ocean and the fresh water basins were cooled down to arctic temperature, even on the northern coast of Spain. Almost innumerable finds illustrate these facts and they have been studied with painstaking care by a number of specialists all over Europe.

Secondly, there is unanimous agreement that man was in Europe even before the last period of severe cold. In the Somme Valley, France, primitive stone implements of man occur in association with animals quite different from those mentioned above. The arctic forms are wanting—no reindeer, no mammoth, no animals of the tundra. A southern elephant was living there instead of the mammoth, and the hippopotamus, an animal which can not live in waters that freeze over, was found in the rivers of France and England. In the same rivers a bivalve, *Corbicula fluminalis*, was common which is now limited to Asia and Africa. All these facts exclude a glacial climate at this period. Moreover, from the Seine Valley calcareous tufas have been described, containing plants which require an average temperature 4° to 5° higher than is the temperature to-day at the same place. Prehistorians designate this stage of human culture as Chellean. Now, the following Acheulian stage, whose implements of a finer make rest immediately upon those of the Chellean, contains plant remains of a colder climate and the bones of mammoth and reindeer, thus demonstrating that the cold with a new glaciation was approaching.

Hence it is proven beyond any reasonable doubt that man was in Europe during a rather genial climate preceding the last glaciation, and that he witnessed this process of glaciation from its beginning to the complete disappearance of the ice. This conclusion is not based on a few stone implements, nor on a few bones of man found somewhere. It has been reached by the conscientious study of numerous prehistoric stations of man throughout central and southern Europe. These studies were carried out by well-trained scientists, amongst whom a number of Catholic priests, such as Prof. Hugo Obermaier, the Abbé Henri Breuil, the Abbés A. and J. Bouyssonie, Prof. F. Birkner, are leading authorities. Owing to these researches a great number of skeletal remains of man of the glacial period have been

unearthed. Man of the Neanderthal race, living in the first portion of the Old Stone Age, in the cultural stages of the Acheulian and Mousterian, is represented at least by 11 skeletons, of which 7 are in good preservation, and by fragmental remains of 19 individuals. Neanderthal man was succeeded by quite a different human race which lived in the last part of the Old Stone Age and the glacial period. Fifty-two skeletons of this race are extant and portions of other skeletons representing about 30 individuals.

AN ABSOLUTE CHRONOLOGY FOR LATE GLACIAL AND POSTGLACIAL TIME

Are there reliable methods for dating back these geologic events and for expressing in millenniums the time elapsed since their occurrence? Many attempts have been made in the past to determine this time. Most of them did not go beyond rough estimates, leaving much to subjective feeling and fancy. The cutting of the Niagara gorge below the falls is supposed to furnish a good measure of the time elapsed since the recession of the ice, for these falls could not begin their work before the ice sheet covering North America beyond New York City retreated to a place north of the present falls. But there are so many uncertainties in the determination of this time that the figures given differ all the way from 7,000 to 39,000 years. Besides, the connection of this event with the appearance of man in Europe is still very problematical. Even more open to exception are calculations based on the thickness of deposits left in lakes after the recession of the ice.

The study of such deposits in lakes, however, was developed by Prof. Gerard Baron de Geer, of Stockholm, into a new method which is recognized as the best and most reliable one for measuring the millenniums since the definite recession of the ice from a given locality. Professor de Geer reported on this method and its results to the Eleventh International Geologic Congress sitting in Stockholm in 1910.[2] Since then it has been applied to numerous localities both in Europe and in America by De Geer and his students and coworkers, and it has found unreserved approval and acceptance from geologists.

To illustrate De Geer's procedure we may take an example of a recent glacier. The melting waters of the Victoria Glacier in the Canadian Rockies (Alberta), after a course of about 1 mile, are poured into Lake Louise, a mountain lake 1¼ miles long and one-half to three-eighths mile wide and 5,760 feet above sea level. During the summer months the melting waters of the glacier are turbid and milky from the detritus carried away from the melting ice. In the lake

[2] A geochronology of the last 12,000 years, Congrès géol. intern. XI. Compte rendu, Stockholm, 1912, p. 241 ss.

the coarser material soon settles, while the finer clay remains suspended and falls down very slowly in late fall or winter, when Lake Louise is frozen all over with an ice cover about 40 inches thick. The deposits at the lake bottom are, therefore, found to consist of coarse layers of silt and sand alternating with fine layers of clay; the coarse sediments being laid down during the melting period, the fine clays during the winter when there is no, or else very little, melting of the glacier. There is also a difference in the color of these two layers, the winter layer being, as a rule, of a darker hue.[3]

The same conditions as observed at present in Lake Louise occurred very frequently during the melting of the enormous ice sheets which covered the northern part of Europe and North America during the glacial period. At many places the drainage of a district was blocked by the deposits made by the melting ice sheet, when the front of this ice sheet stood for a considerable time at the same spot. As a consequence when the ice front later receded the dammed-up melting waters gathered in lakes, forming coarse layers in summer and finer and darker ones in late fall and winter, thus giving origin to banded clays. One pair of these bands (or varves, after the Swedish word) forms in one year, just as an annual growth ring in trees forms during one year. (Pl. 1.)

Such " varved " clays occur on a large scale in southern and central Sweden, where the rivers of the late glacial ice sheets, carrying the detritus of the ice, poured their water into such lakes. Here De Geer began his studies and counted with his students the varves from the Scania Peninsula in southern Sweden to Jämtland in central Sweden, over a distance of 800 kms. (500 miles). He found 5,000 pairs of layers requiring 5,000 years for their formation. Thus the retreat of the ice front from Scania to central Sweden occupied 5,000 years. This retreat was accomplished slowly in Scania, about 75 m. (250 feet) a year; farther north it increased to 100 m. (328 feet). Later, the melting set in rapidly and the yearly recession was from 100 to 300 m. (328 to almost 1,000 feet).

At the end of these 5,000 years the shrinking ice was bisected and retreated into the Scandinavian mountains. That was the end of the glacial period and the beginning of postglacial conditions. The duration of postglacial time was in a similar way determined by counting the varves laid down in the postglacial lake Ragunda and in the former fjord of Ångermanälven. The result was about 8,700 years with an uncertainty of 100 to 200 years; i. e., postglacial time lasted 8,500 to 8,700 years from its beginning until 1900 A. D. Therefore, southern Scania was freed from ice 8,700+5,000=13,700 years, or, using the lower figure, at least 13,500 years before 1900 A. D. (In

[3] W. A. Johnson, Sedimentation in Lake Louise, Alberta, Canada, Amer. Journ. Sci., 5th series, vol. 4 (1922), p. 376 ss.

the publication cited above[4] De Geer had calculated 12,000 years, based on studies in Ragunda Lake; these studies were regarded as preliminary only; the higher figure is based on more exact work of a later date.)[5]

De Geer's method was readily accepted and approved on the part of geologists, even when he first reported it to an international audience and showed characteristic varved clays in Sweden to the members of the Geologic Congress. Since then this approval has become universal amongst geologists and prehistorians. On the occasion of the Twelfth International Geologic Congress at Toronto in 1913, the Canadian authority on glacial geology, A. P. Coleman, said: "Probably the most accurate chronology is that worked out skillfully and patiently by Baron de Geer and his assistants."[6] The French paleontologist Boule calls De Geer's method "la plus ingénieuse et la plus suffisante."[7] Prof. James W. Goldthwait, of Dartmouth College, writes in his introduction to Antevs's publication reporting on the application of De Geer's method to America: "An investigation so precise in method and execution and so suggestive will give fresh impulse to our studies of Pleistocene glaciation."[8] Robert W. Sayles, geologist of the Harvard University Museum, after a careful examination of all the factors which might influence the deposition of the clays in question, reaches the conclusion: "I feel convinced that the seasonal theory is in a very strong position and that the danger of its being abandoned is very slight."[9] The late Prof. Eduard Brückner, of Vienna University, one of the leading authorities on the glacial geology of the Alps, accepts unreservedly De Geer's method.[10]

Indeed, all modern geologists take it for granted that the chronology based on clay varves is reliable. There exists no serious adverse criticism of the method. Absolute chronologies based on clay deposits were regarded with skepticism and mistrust, as long as the thickness of the deposits was taken as the measure of time. Climatic conditions are so variable and their influence on the amount of clay carried along by rivers is so unaccountable that they can never afford precise measurement. This disturbing factor does not enter into the new method. Variations in temperature and precipitation certainly influence the thickness of the clay layers, but these

[4] Cf. note 1.

[5] R. Lidén, Om isavsmältningen och den postglaciala landhöjningen i Ångermanland, Geol. Fören. Förhandl., Stockholm, 1911, vol. 33, pp. 271–280; G. de Geer, On the solar curve, as dating the Ice Age, the New York Moraine and Niagara Falls through the Swedish time scale, Geografiska annaler, 1926, vol. 8, pp. 274–284.

[6] Congrès géol. intern. XII., Compte rendu, Toronto, 1913, p. 435.

[7] Marcelin Boule, Les hommes fossiles, Paris, 1921, p. 60.

[8] Ernst Antevs, The recession of the last ice sheet in New England, Amer. Geogr. Soc., Research series no. 11, New York, 1921, p. IX.

[9] Museum of Comp. Zoology, Memoirs, Cambridge, Mass., 1919, vol. 47, p. 61.

[10] Zeitschrift für Gletscherkunde, 1921, Bd. XII, p. 55.

variations are no longer unknown quantities; they are plainly legible in the varves themselves. In a year with a warm summer the coarse portion of the varve will be thick; in a colder year the varves may shrink to small lamellae. Exceptionally rainy seasons and periods of excessive heat and drought will undoubtedly modify the depositions in lakes at the ice front. But such irregularities can always be distinguished from the seasonal varves if the latter are studied with due care over large areas.

De Geer's method has also been applied to varved clays in North America during the last decade. Antevs started this work in the Connecticut Valley. Varves were counted from Hartford, Conn., to northern Vermont, over a distance of 185 miles. Later, a number of varved clay deposits were studied in Canada, in Wisconsin and Minnesota, and recently by Chester A. Reeds in New Jersey and in the Hudson Valley, New York.

The researches have even been extended to Argentina in the Southern Hemisphere and to the Himalaya region. It has not been possible in these cases to construct a continuous time scale as in Scandinavia. But the method itself has been firmly established and has stood the test by many independent workers in widely separated areas.

EXTENSION OF THE CHRONOLOGY BACKWARDS

The duration of late glacial and postglacial time in Scandinavia has been firmly established by De Geer and his colleagues. In round numbers, 13,500 years have passed since central Scania was freed from ice. How can this fact be used toward solving the problem of the age of the human race? This age is certainly higher than the above figure. In the first place, it must be taken into account that the ice border halted a considerable time before it melted away, forming moraines—that is to say, long stretched hills—composed of the detritus brought by the ice. Recently the duration of this stoppage, just before its final recession, has been determined by studying varved clays laid down by the melting waters of the ice in lakes of southwestern Scania and in the Danish islands Sjelland and Fyen. (See De Geer, citation 4 above.) This halt of the ice lasted almost 2,000 years, which, therefore, must be added to the above figure 13,500.

Furthermore, it is well known that the ice before this time covered the northernmost part of Germany, halting there again for a considerable time, as is seen from the formation of the very extensive elevations, the moraines of the Baltic Ridge, in which lakes and lakelets are abundantly developed, as in the moraines of Wisconsin and Minnesota. The duration of this stoppage and the time required for the retreat from northern Germany to southern Scania have not yet

been determined by exact methods. The latter can only be estimated from the rate of recession found in Sweden, while the duration of the stoppage must be derived approximately from the moraines deposited by the ice during the halt or the oscillations of its border. De Geer assumes 2,500 years; adding these to 13,500+2,000 found before, his final figure is 18,000 years; that is to say, 18,000 years ago the German Provinces of East and West Prussia, Pomerania, Mecklenburg-Strehlitz, and the eastern part of Schleswig-Holstein were still covered with mighty ice sheets. (Fig. 1.)

At a still earlier period the ice sheet reached farther south into the southern part of the Province of Brandenburg and south of Poznan in Poland. No data are at hand to determine the recession of the ice from this area until it reached the Baltic Ridge. An estimate of 1,000 years would, however, be in fair agreement with the observations made farther north. Thus, in all, the ice began its retreat from northern Germany about 19,000 years ago. It must be borne in mind that of this figure a little more than 15,000 years are the result of precise measurement. The remainder is a conservative estimate. It might well be that the ice stood a considerably longer time in northern Germany, its border alternately receding and readvancing. Thus Ernst Antevs arrives at essentially higher figures in his recent publication: "In all, the uncovering of the belt between the Great Baltic, or the Pomeranian moraine, and northeastern Scania must have taken many thousand years, probably 10,000 to 15,000."[11] Evidently such assumptions can not be definite, because they are not based on the counting of clay varves. Therefore the lower figures are here preferred, in order to avoid all statements which can not be proven, although the higher figures may be true or may approach the truth.

It will be recalled that man during this last glaciation was in Europe, struggling with the cold in southern France and northern Spain, and as companion of the arctic animals and plants. Furthermore, it was shown that man was in Europe before this severe cold arrived, since he was living with animals and plants requiring a much warmer climate not only in southern countries but as far north as Weimar in Germany. It is, of course, impossible to reconcile such a mild climate in central Europe with a glaciation and a large ice sheet in northern Germany. We must, therefore, conclude that at that period northern Europe was as much free from ice as it it at present, or even more so, if the indications of a higher temperature than to-day are reliable. With a new deterioration of the climate, then, the ice again took possession of central Europe, moving slowly from Scandinavia to central Germany.

[11] Ernst Antevs, The last glaciation, Amer. Geogr. Soc., Research series No. 17, New York, 1928, p. 160.

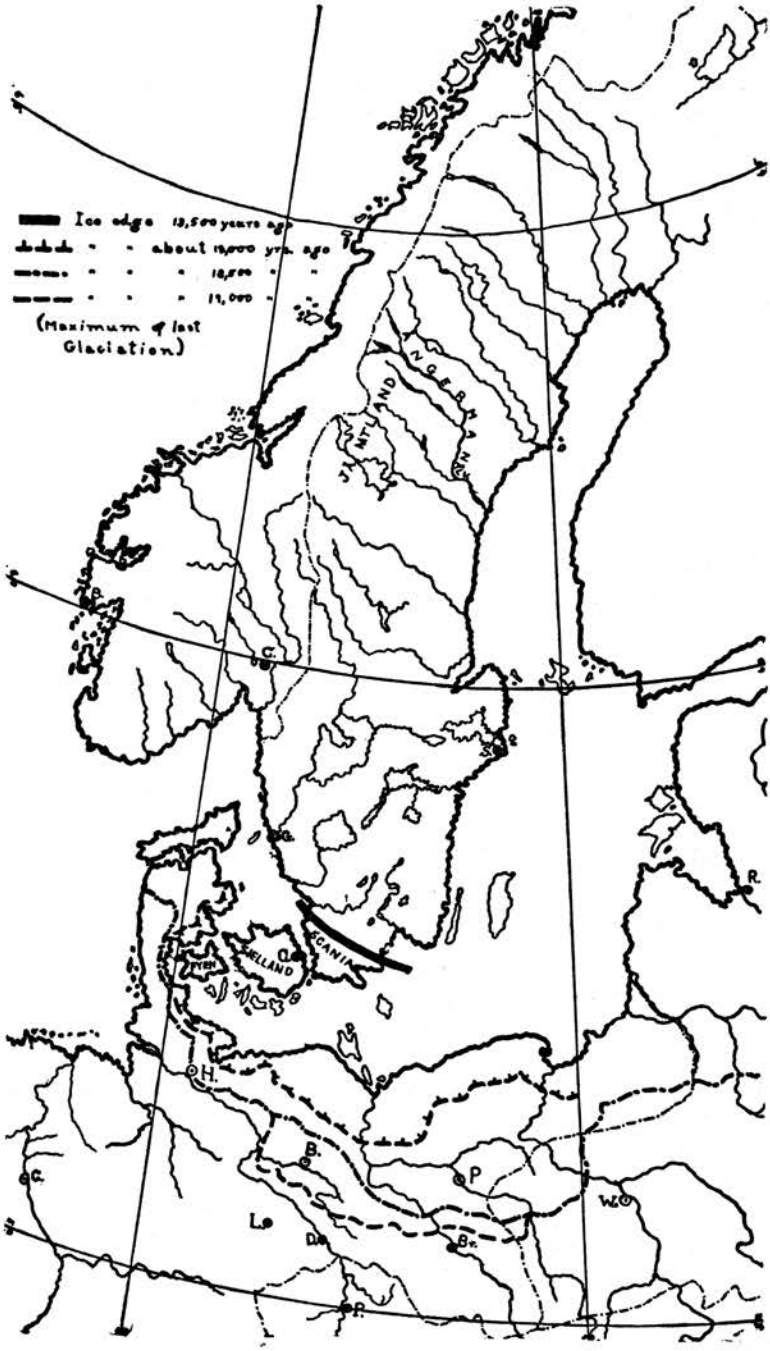


FIGURE 1.—The extension and recession of the last ice sheet in northern Europe

When this last glaciation was at its maximum, man was already living in central and southern Europe.

THE DURATION OF THE ADVANCE OF THE ICE

To determine the time needed for such a readvance no exact methods are at hand. We meet here with many uncertainties and unknown quantities which prevent an exact measurement. Moreover, we do not know how long the ice front stopped at the greatest extension of the inland ice, and how long man was in Europe before the ice started its readvance. Only an estimate of the readvance of the ice will be attempted in the following paragraphs.

The average motion of recent glaciers and ice fields is fairly well known. The Alpine glaciers move at a daily rate of 12 to 20 inches. There are examples of more rapid motion; this happens where a glacier is pushed with high pressure into a narrow valley or where the ice slides over a steep slope. Such conditions are, for example, responsible for the exceptional velocities of glaciers at the western edge of the large ice sheet of Greenland, where daily motions of 33 to 66 or even of 105 feet are recorded. It would be wrong to attribute such a speed to the whole body of the inland ice. The late Prof. Thomas C. Chamberlin long ago warned against such a procedure: "There is a widespread misapprehension as to the average rate of movement of the ice fields of Greenland. * * * In certain fiords, that lead out from great basins into which broad fields discharge their ice and their surface waters, and thus furnish the conditions for an extraordinary rate of movement, the rate of motion, at least during the summer, is unusually high, and these exceptional cases have been taken as representative of the movement of the border of the inland ice. This is very far from being true. The average movement for the whole border of the ice field is quite certainly less than 1 foot per day, and it is more likely less than 1 foot per week."[12] Others speak of a forward motion of only a few meters annually. If it were more, the ice would soon cover those parts of Greenland which for centuries have been free from ice, the wastage of the ice being exceedingly small on account of the short melting season.

The Pleistocene ice sheets were of enormous thickness, and they advanced, as a rule, over a flat country, spreading out over a very large area. The surface slope, which is of the greatest importance for the rate of movement, has been found to be very slight, as far as can be ascertained. All this points to a slow motion of the clumsy ice masses, although an exact rate can not be given. The southernmost portions of the ice may have moved faster than the Greenland ice because, reaching into an area of milder climate, the greater part of the ice was not far from its melting point. Conse-

[12] T. C. Chamberlain and R. D. Salisbury, Geology, 2d ed., 1907, Vol. III, p. 430.

quently, the flow of the ice became easier and the rate of movement increased, as is observed in Alpine glaciers far below the snow line. Even under these conditions a motion of 1 foot per day must be considered as high. However, assuming such a rate, it would take about 11,000 years for the ice to travel the distance of 750 miles from its origin in Scandinavia to northern Germany.

This figure gives an idea of the length of time required for an ice sheet to move over great distances. It does not, however, give a measure of the advance of the ice border. It is well known that the ice in moving forward melts. The amount of melting is in some cases so considerable that the ice front recedes, although the ice as a whole pushes steadily forward. Thus the front or tongue of the majority of the Alpine glaciers is retreating. The melting process was undoubtedly also active in Pleistocene time; during the advance of the ice its edge was melting. This wastage may have been small, compared with the motion of the ice, especially when the cold was at its climax; it may have been considerable when the climate was as yet less severe. In any case, on account of this melting, the above figure must be increased by an uncertain amount. To simplify the problem, this factor may be neglected, bearing always in mind that the figure is rather below the real value than above it.

As the final result of the preceding deductions it can be stated: Thirty thousand years ago man was certainly in Europe, living in a rather warm period preceding the last glaciation. This figure seems to be well established, and no scientist will raise serious objection to it so long as it is regarded as a minimum.

WHY DO GEOLOGISTS ASSIGN A STILL HIGHER AGE TO MANKIND?

However, the great majority of geologists and prehistorians assume considerably higher figures for the age of the human race. Some reasons for such an assumption have already been alluded to. The rate of movement of the advancing ice seems in all probability to have been less than that assumed in the present paper, and therefore the time of advance longer. Moreover, the melting of the ice during its advance was neglected. Furthermore, how long was man living in a genial climate before the temperature dropped to such a level that the ice started its advance to the south? There are good geological reasons for concluding that the interglacial period preceding the last glaciation lasted much longer than the postglacial period, which latter had a duration of at least 18,000 years for northern Germany. (Pl. 3.) If man was already in Europe at the beginning of the last interglacial, then many thousands of years must be added to the above figure.

Finally, we have to take into account another possibility. The cradle of mankind was hardly in Europe. Even from the purely

scientific viewpoint one has to look elsewhere for man's birthplace. The question then arises: How long did man live in his place of origin before he migrated into Europe? And even in Europe man may have appeared much earlier than during the last interglacial period. For his presence during this period we have conclusive proofs confirmed by numerous observations and by the unanimous agreement of scientists. There are, however, strong indications that man was in Europe in the second last interglacial period. The human jawbone found at Mauer near Heidelberg in association with mammals of a more ancient type is ascribed by Dr. Hugo Obermaier to this second last interglacial. Likewise, some prehistoric sites containing stone implements together with the same ancient animals (Abbeville, France) are placed in the same period, the pre-Chellean, by Father Obermaier.[13] Many other geologists place even the Chellean in this second last interglacial period. If these views be correct, the age of mankind would exceed the above figure by many millenniums, because another recession and another advance of the ice must be added and also the unknown duration of the second last interglacial period.

Even so, the possibilities are not yet exhausted. The problem of Tertiary man has been very warmly discussed ever since the Abbé Bourgeois first advanced such a thesis in 1863. As skeletal remains of man are to date lacking in deposits of this period, the whole discussion has centered around flints of peculiar shape, the eoliths. According to some, these indicate manufacture by an intelligent being, while others consider them the products of mere natural processes. The best experts in paleolithic industry rejected the hypothesis of the human origin of eoliths, and thus the problem of Tertiary man seemed to be settled in the negative. However, about a decade ago flints were found in East England, near Ipswich, Suffolk, which revived the old controversy. These flints, evidently of great age, are considered by the great majority of experts as genuine human implements, although some specialists still reserve judgment. These implements are found in two horizons: At the base of the red crag and in its upper portion. The red crag is a marine deposit of the upper Pliocene (end of Tertiary time). The shells occurring in this crag, especially in its upper part, are partly arctic, announcing the approach of the glacial period. The Abbé H. Breuil, one of the ablest and most critical students of paleolithic stone implements, regards the flints found in the upper horizon of the red crag as intentionally made by an intelligent being. Of a number of the peculiar flints occurring at the base of the red crag, he says it is "absolutely impossible to distinguish them from the classical implements" (that is, im-

[13] See: M. Ebert, Reallexikon der Vorgeschichte, Vol. X, pp. 241 and 242, "Préchelléen," by Obermaier.

plements of later periods which are universally recognized as made by man). "The traces of fire are undeniable, whatever may be their origin."[14] L. Capitan, another expert, is even stronger in his verdict on certain implements of the same place: "If one would deny the genuineness of this piece, he must reject the greatest part of scrapers of the Mousterian. * * * These are flints purposely shaped by a rather skillful hand."[15]

Those who accept the opinion of these specialists date man as far back as the end of Tertiary time, or, what is more to the point, the beginning of the glacial period, when the inland ice was for the first time advancing toward central Europe. No wonder that they figure upon a very high age for the human race. If man was witness of three or four advances of the ice, if he was existing during two or three interglacial periods each of them of much longer duration than postglacial time, figures as high as several hundred thousands of years do not surprise us.

The time has not yet come to decide definitely for or against such assumptions. Until the skeletal remains of assumed preglacial man are discovered, some doubt is possible. It may also be, as Obermaier suggests, that the red crag, in which the supposed implements occur, belongs to the first glaciation in England (cold climate). If this be the case, man living during this period was not Tertiary man, although he must have appeared very soon after the close of the Tertiary.

In recent years a number of skeletal remains of a primitive man have been unearthed in China. Geological and paleontological evidence seems to point to a very high age of this man. Father Teilhard de Chardin, S. J., geologist of the Tientsin University, gives a succinct report of the discovery in a recent issue of "Primitive man."[16] According to him Sinanthropus Pekinensis belongs to the Lower Quaternary, while Neanderthal man was living in the Middle Quaternary. That would raise the figures for the absolute age of mankind considerably.

Up to the present the exceedingly high figures for the age of mankind have been derived from those theories which take it for granted that Europe was repeatedly glaciated, either three or four times. There are still geologists who do not accept long interglacial periods. They assume that the ice never entirely left the glaciated area during the whole Ice Age. The interglacial periods of others are to them only minor oscillations of the ice front. An advocate of such an opinion was Nils O. Holst, a Swedish geolo-

[14] Revue anthropologique, vol. 32, 1922, p. 228.

[15] Ibidem, p. 131.

[16] Teilhard de Chardin, Sinanthropus Pekinensis, Primitive Man (Publication of the Catholic Anthropological Conference, Washington), Vol. III, 1930, pp. 46–48.

gist, who estimated the duration of the entire Ice Age as 17,000 years and who ascribed to mankind an age of 30,000 years. There are still a few such monoglacialists left, but their number is fast dwindling away. Indeed, it is very difficult to invalidate the weighty evidence for repeated advances and recessions of the ice sheets. A warm climate, as is known from deposits lying between those of two glaciations, is certainly not reconcilable with big ice masses at no great distance. If, for instance, in what are evidently interglacial beds near Toronto, Canada, remains are found of such plants as grow at present in southern Pennsylvania, or if close to Hudson Bay in similar deposits tree trunks occur of 18 inches thickness, the climate must have been at that time even milder than to-day and the country must have been free of ice far to the north.

However, it is still disputed how many times such changes took place. The number of glaciations usually is given as three in northern Europe and as four in the Alps. The overwhelming majority of geologists agree that the assumption of at least two independent glaciations with a long warmer interval is imperative. Recently an anthropologist of Vienna, J. Bayer, drops the first glaciation in the Alps as unproven, and contracts the last and second last glaciation into a single one, only separated by a minor oscillation of the ice front. Thus two large glacial periods remain with one interglacial period of long duration, in which latter man was present.[17] Accordingly, the duration of the entire Ice Age is considerably diminished, although even Bayer speaks of about 200,000 years. On account, however, of the strong opposition of experts, this chronology can not be taken as a standard.

CONCLUSION

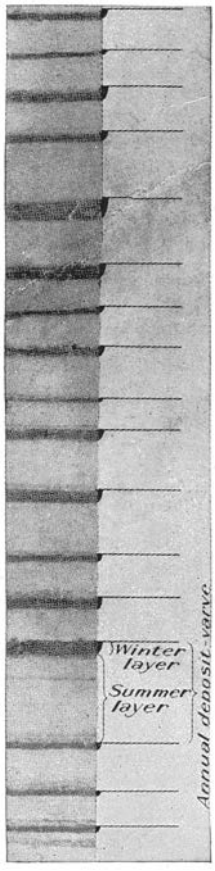
It is evident from what has been said that there are many uncertainties which block any attempt to assign a definite figure for the age of mankind. On the other hand, it would be unreasonable and unscientific to reject all figures as uncertain and unreliable. There are facts which are obvious and which are accepted unanimously by all geologists, and these facts warrant the conclusion that man was undoubtedly in Europe 30,000 years ago. Of this number of millenniums the first half is determined by exact methods, as set forth in this paper; the other half is based partly on an estimate of the recession of the ice where this recession can not yet be measured directly, partly on a very conservative estimate of the time required for the advance of the ice front from northern to central Europe. Future development of these methods as well as new discoveries may raise this minimum figure considerably and may place on a more solid

[17] J. Bayer, Der Mensch im Eiszeitalter, Wien, 1927.

basis the theories of those who stand for a much higher age of mankind. However, it seems impossible that the figure of 30,000 years will ever turn out to be too high as a reasonable estimate of the minimum age of the human race. In any case, the present essay clearly points out that it is impossible to reconcile the well-known facts of human antiquity with such figures as 6,000 to 8,000 years. No theological problem is involved, it may be added in conclusion. Theologians, even the more conservative, acknowledge full liberty to deviate from the figures of the older exegesis and declare that the problem of the age of mankind is, like that of the age of the earth and of the universe, one which has to be solved by secular science.

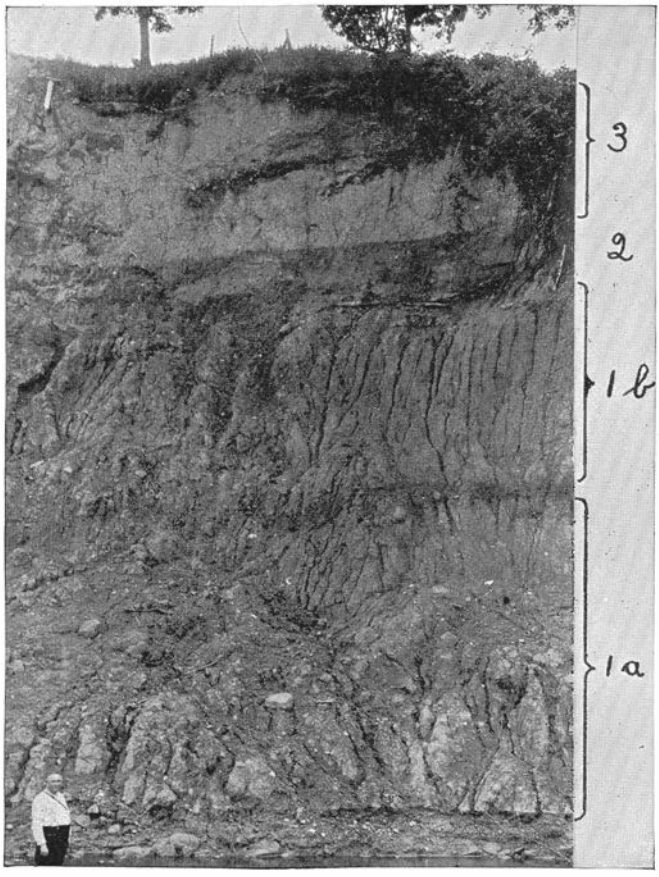
VARVED GLACIAL CLAY, SANDY FALLS, 6 MILES WEST-NORTHWEST OF TIMMINS, ONTARIO

From Memoir 146, Canada Geological Survey, Plate II, A. Ernst Antevs, Retreat of the last ice sheet in Eastern Canada. (Reproduced by courtesy of Geological Survey of Canada.)



VARVED GLACIAL CLAY FROM UPPER PART OF SECTION AT ESPANOLA, ONTARIO

Actual length 18 inches, laid down in 17 years. (Ibid., Pl. I, e.) (Reproduced by courtesy of Geological Survey of Canada.)



FARM CREEK EXPOSURE, 7 MILES EAST OF PEORIA, ILL.

3, Bowlder clay, deposited from the melting ice sheet of the last glaciation, fresh on the bottom, weathered on top. Overlain by gravel brought by the melting waters of the receding ice; 2, loess, an eolian deposit during an interglacial period; 1*a* and 1*b*, bowlder clay of an earlier ice sheet. 1*b* is its weathered portion, at least 15 feet thick (down to the dark band in the photograph); 1*a* is a fresh blue bowlder clay. The photograph illustrates a feature common to such deposits of the Ice Age, both in America and in Europe. The earlier glacial bowlder clay (1) is weathered to a much greater depth than the upper one (3), although the latter, at the locality of the picture, became exposed to the influence of the atmosphere about 20,000 years ago. Moreover, the decomposition of the older glacial deposit must have been completed before the region was covered by the last ice sheet, because later this ice sheet and its deposits protected the older bowlder clays against decomposition. Therefore, a much longer time was needed for the interglacial period than the postglacial 19,000 to 20,000 years. (Photo by Rev. Henry Retzek.)