

The Recent Progress of Quaternary Study in China^{*)}

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With 4 Text-figures and 1 Correlation-table

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I) INTRODUCTION

Quaternary studies in China up to May 1933 have been summarised in a memoir published under the title "Fossil Man in China"¹⁾. Since then the members of the Cenozoic Research Laboratory as well as many colleagues from other Institutions have carried out further researches all over China and made a considerable progress. Most of the reports is published in the Publications of both the Geological Survey and Society of China issued 1934—1937. In the present paper I am going to give a summarized account of all new knowledges obtained in this period.

Since the Quaternary study in China is not yet so advanced as that in Europe and since we have the actual difficulties met in the field in separating Quaternary and other late Cenozoic deposits, the work could hardly have been done, if we are not dealing with the whole Cenozoic. Consequently, the present paper may not leave out entirely the question of older formations than that of Pleistocene.

I shall deal with the present subject, firstly, on a regional account and then a special part relating to the Choukoutien Excavation, which is particularly important. Lastly we shall encounter a part on the problems of correlation of Quaternary in China and Europe.

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II) REGIONAL STUDIES OF QUATERNARY GEOLOGY

For the regional studies I shall divide the whole China into three parts: North, Central and South.

A) North China

a) Western Hills and Hopei Plain *)

During the past few years a detailed geological survey has been carried out extensively in the Western Hills by the members of the Geological Survey²⁾. The part of Cenozoic study undertaken by the members of Cenozoic Laboratory is condensed in an article by YOUNG and BIEN³⁾.

In a cave named Chaoyangtung, Fangshanhsien, about 800 m above the Hopei Plain, a bed of consolidated gravel is found, of which the composition of the sediments and the mode of accumulation were found both curiously similar to the "Upper Gravel" of Choukoutien⁴⁾, which is only about 70 m above the same Plain. At the same time along the foot hills of Western Hills, YOUNG and BIEN observed some similar gravels, situated not more than 100 m above the Plain in question (Fig. 1). All the gravels of 800 m, 100 m and 70 m are very probably of the same age, say, Sammenian I or late Pliocene.

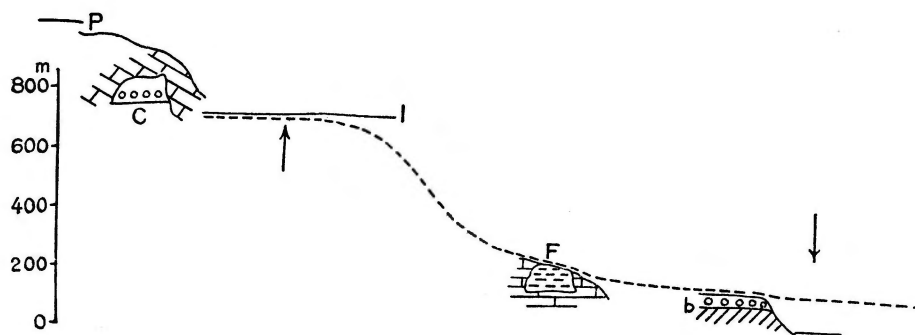


Fig. 1. An ideal sketch showing the relative position of the Chaoyangtung gravels (C), Fish pocket of Choukoutien (F) and the boulders at the top of the low ridges at the foot of the Western Hills (b). The elevation is indicated in meters at the left side. P. Peitai Summits, i. the supposed intermediate physiographical stage. The dotted line with arrows showing the warping of the old Tanghsien surface (after YOUNG and BIEN).

How to explain the fact is a question impossible to answer yet. But suggestion might be made in favour to a hypothesis that the Western Hills have been rising since Pliocene time up to present.

Père LICENT has recently contributed an important work on Quaternary in giving the record of a drilling of a deep well at Laoshikai in Tientsin⁵⁾. He also compared with the data obtained from other deep wells in Peking and Tientsin.

The result tells us that, up to 861.5 m of depth below sea level in Tientsin, the sediments throughout encountered by drilling no rocks but were entirely sunk through Quaternary unconsolidated or only locally cemented deposits. Fresh water shells have been recorded: *Planorbis*, a gastropod ab-

*) The Hopei Plain was formerly called Chihli Plain (*Tcheu Ly Plaine* in French). It is a part of the Great Huangho Plain of GRABAU.

undant in every where in the Plain, is found in the sediments of 90 m and 800 m below the sea level; *Lamprotula* is also encountered in the depth of 330 m.

In considering of the above observed facts, it leads several geologists to think that the Hopei Plain has been sinking down during the Pleistocene time.

No matter of the rising of Western Hills or the sinking of the neighbouring Hopei Plain, it points that a vertical movement of land mass might occur constantly during Quaternary time. GRABAU explained the sinking of the Plain may be due to the cause as the accumulation of masses on the slope⁸⁾ and I have tentatively explained by the un-equilibrium of the "blocks" between the mountainous region of Western Hills and the low land of Hopei Plain⁷⁾. My arguments are chiefly basing upon the gravimetric survey in North China carried out by Lejay and others⁸⁾.

b) Shansi Mountainous Region

Between the highly raised ranges in the mountainous region of Shansi there are many inland basins filled with lacustrine deposits of late Cenozoic age. The Taiku Basin is well known since years ago⁹⁾ and is considered to be of great significance in the study of late Cenozoic stratigraphy. Another important basin, the Yushe Basin, filled with lacustrine sediments of all Pliocene and Pleistocene age was firstly studied by TEILHARD and YOUNG¹⁰⁾ and recently thoroughly surveyed by LICENT and TRASSAERT¹¹⁾. From the different fossiliferous zones LICENT and TRASSAERT collected a great quantity of well preserved vertebrate fossils of early, middle, and late Pliocene ages.

The Yushe Basin is quite important from palaeontological point of view, since it bears the fossils sufficiently for us to make a complete understanding of the evolution of Mammals through all Pliocene and up to early Pleistocene time.

c) Shantung Peninsula

YOUNG and BIEN had made a general study of Cenozoic geology in Central Shantung in 1935¹²⁾. Their observations on the physiographic features are worthy while to note in the present paper.

A cycle of physiographic change as erosion and deposition has been noticed between the time interval of late Pliocene and early Pleistocene in North China and was named provisionally as "Z Erosion" and "Upper Sanmenian Sedimentation"¹³⁾. In the present region YOUNG and BIEN have noticed that during the "Z Erosion" period the main streams have lowered their channels to the present river level and reduced the interstream area into a series of low convex swells. Followed this period there came the accumulation of the concretionary reddish loams (lower Pleistocene or *Choukoutienian*) which have covered all the relative depressed areas.

A later erosion or the Chingshui Stage (middle Pleistocene) dissected the reddish loam along the old streams and interstreams to a moderate depth. The Chingshui down-cutting was succeeded by the accumulation of brownish-gray loam and loess of Malan type. From late Pleistocene up to the present the physiographic cycle is still going on as indicated by the aggrading of the main streams in this area.

Later in 1935 YOUNG again made a survey of Cenozoic geology in north Shantung¹⁴⁾. His scientific results are chiefly interested in the early Cenozoic stratigraphy. In reddish loams some fossiliferous sites were located, which have yielded *Euryceros* deer and other fossils of *Choukoutien* type (early Pleistocene).

d) Honan, Shensi, and Kansu Regions

A survey of Cenozoic geology in province Honan and a part of province of Shensi was practiced by YOUNG and myself in 1933¹⁵). In this trip we have observed: 1) the late Cenozoic formations which are not so simple as we formerly assumed but a "complex" which composes of the red clay of Pontian age, the reddish loam of Sanmenian and Choukoutienian time (Late Pliocene and early Pleistocene) and the Loess (middle and late Pleistocene); 2) the evidence which may lead us to suggest that there has been a vertical tectonic movement of pre-Loessic and post-Pontian time in this area.

In 1936 YOUNG and BIEN started a general study of Cenozoic geology in Kansu province¹⁶). In this area they found some geological formations of which the Anning Series (earliest Pleistocene or Sanmenian II), Loess of Malan type (middle and upper Pleistocene) and the „Kaolan Aggradation“ (Sub-recent) are interesting to us. The Anning Series is chiefly composed of orange sands and basal gravels. No fossil was recorded. But from stratigraphical study it is undoubtedly of very early Pleistocene age (or Sanmenian II).

The loess occurs in this region as both slope and valley deposit and does not differ from that known in other region of North China.

The Kaolan Aggradation as named by YOUNG and BIEN is well developed in central Kansu. It is represented by the fillings of 20 m thick in maximum. In the Hsienshuiho valley the deposition is composed of loams and clays, while in the Huangho valley (or the valley of Yellow River) composed of reworked loess and basal gravels. No fossil was found, but, as learned from its stratigraphical position, it seems to be very late Pleistocene or even partly recent.

The physiographic changes have been observed in Kansu are quite important even for a general consideration of the geo-physical study of whole China. The pre-Anning Series erosion is very evident in Kansu and a term "Huangshui Erosion" is proposed.

After the deposition of Anning Series it was followed by the Chingshui Erosion which had dissected the landscape into a mature stage.

The Panchiao Erosion, the post loessic dissection, is found to be strongly developed in this district. Some times the main rivers cut down into the old surface as deep as 40—60 m. The streams have rejuvenated and deep trenches have been cut. Such a strong dissection, as suggested by the two authors, may be related with a strong uplift of land mass.

e) Manchuria

During the last few years Quaternary study has been little done in Manchuria. Nevertheless LOUKASHKIN, AHNERT, TOKUNAGA and others had certain contributions and their works are summarized in an article published in "Early Man"¹⁷). The following two localities may be well representing the Pleistocene of Manchuria.

Chalainor. From the brown-coal minings near Chalainor in North Manchuria Mammalian fossils, such as *Elephas primigenius*, *Rhinoceros tichorhinus*, *Bos primigenius*, *Bison priscus*, *Antelope* sp. etc. have been recorded. This fauna is obviously of late Pleistocene and contemporary to that from Kushiangtun near Harbin, to be mentioned below.

In 1934 the same fauna is also found by LOUKASHKIN on an ancient terrace of Argun River near Halair, south east of Chalainor. He is expecting to find some Palaeolithics there in a future excavation. In the same region however we should note that Neolithic and Mesolithic sites were known years ago, but so far no Palaeolithic has ever been found.

Kushiangtun. In the brick yards of Kushiangtun, a village on the bank of Wenchuanho, near Harbin, a rich fossiliferous locality has been discovered. An excavation was executed by LOU-

KASHKIN, YIN and PONOSOV in 1931¹⁸). Later in 1934 TOKUNAGA and others continued to make another exploration, very extensive indeed, at the same locality. The fossils, found in the black earth and fine sands there, are: *Elephas primigenius*, *Bos primigenius*, *Rangifer tarandus*, *Cervus (Euryceros) pachyosteus* (???), *Megaceros* (?) sp., *Equus caballus*, *Rhinoceros tichorhinus*, *Rhinoceros merckii* (??), *Hyaena ultima*, etc. *)

From the above fossil forms we may say without hesitation that the present fauna is of late Pleistocene age and impossible to correlate with that from the *Sinanthropus* site of Choukoutien (lower Pleistocene). Or otherwise, the Kushiangtun fauna is a „complex“ composing of all phases of Quaternary.

The interesting fact however is that TOKUNAGA claims to find stone and bone implements accompanied with the rich Mammalian remains. Judging by the photographs of TOKUNAGA's reports the so-called stone implements are practically some flakes possibly worked by man. In any way no "type" of tools could be recognized yet and consequently it is too much premature to compare with the Palaeolithic industries known in Europe. The bone implements, as they supposed, are very doubtful indeed. Besides some pieces which might be the same type as the Mesolithic or early Neolithic objects found in Hailar and Chalainor region, all the others are but nothing than the broken bone of doubtful origin **). So far there is not any piece, which shows the clear traces of human workmanship. Later and thorough investigation is required.

f) Tsinling Range

The Tsinling Range has been long recognized as a natural geological boundary between North and South China. TEILHARD, BARBOUR and BIEN have had the opportunity to cross Tsinling to study the Cenozoic geology in 1935. Their result has been published in Bulletin of Geological Survey of China¹⁹).

The red concretionary loams of lower Pleistocene time have been observed on both south and north side of Tsinling, but on the northern slope the deposits are more extensive and thicker than on the southern one. No fossil has been recorded, but, in considering of the lithological composition and the stratigraphical position of the sediments, the reddish loams of Tsinling are beyond any doubt belonging to the same formation as that well developed and well known elsewhere in North China. Towards the south the said concretionary loams become thinner and thinner and finally replaced by the Siashu loam of BARBOUR in the Yangtse valley.

As to the Malan Loess in the Tsinling area, it is strongly reduced in the Loho valley and disappeared on the southern slope of Tsinling. But the position is not clear yet as to whether the Tsinling Range is or is not the south limit of the Malan Loess.

B) Central China

In this very region two problems concerning the latest knowledge of Quaternary are extremely interesting, namely, 1) the Pleistocene *glaciation* in Lower Yangtse and 2) the changing of sea level.

1) The Problem of Pleistocene Glaciation in Lower Yangtse.

In 1933 J. S. LEE has found indications which he thinks point to glaciation in Lushan in lower Yangtse²⁰). His arguments are based on the presence of U-shaped valleys, the "Lung" (Drumlin),

*) The determination of fossils marked by (?) seems to be incorrect, as judging by the pictures published by the Japanese scientists.

***) Judging by the published figures the majority of the broken bones either bears the gnawing marks of Rodents as well as the biting traces of Carnivores or shows the characters of naturally cracked fracture.

and the "boulder clay", which is composed of boulders of all sizes from a diameter of two meters down, mixed with the red clay. But BARBOUR has had another view in regarding the presence of glaciation in Central China. After he has had a personal study in the Lushan region, he concluded:

"The balance of the evidence at the present moment appears to be against the hypothesis that Central China has been glaciated within relative recent geological time."²¹⁾

However J. S. LEE, since then, discovered more evidence which is sufficient to confirm the presence of Pleistocene glaciation in Central China, as he claims. The new observations are made in Huangshan, mountains of about 1500—1600 m altitude in south Anhui²²⁾. The evidence is: the U-shaped valleys; the ice abrading surfaces on the granite valley-wall; one polished and scratched boulder; the varved clay and the boulder clay.

WISSMANN accepts the opinion of J. S. LEE and furthermore thinks that he has the evidence for supposing two glaciations during Pleistocene time in China²³⁾.

Further investigation is still going on by J. S. LEE and his colleagues and we hope much more light will be thrown concerning the present problem.

2) The Problem of Changing of Sea Level

In 1936 HUANG and HSU made a trip to Hangchow and have had a detailed study of Tsientang estuary²⁴⁾. They found a well formed river terrace of 40—50 m high above the present Tsientang River or practically the sea level. The terrace consists of gravels of various size, interbedded with sandy clays. They assumed, but with only some negative evidence, that the gravels were deposited in an ancient Tsientang estuary, when the Tsientang River or the sea was 40—50 m higher than the present one.

HUANG and HSU inclined to correlate the gravels in question to the Siashu loam or Siashu (or Hsiashu) Formation of lower Yangtse. As stated in their article, that the Siashu Formation is of late Pleistocene age (early Pleistocene by BARBOUR) and consequently the lowering of sea level occurred in "Post-late-Pleistocene" time, as they concluded.

The problem is, however, far from being solved. First we should search for further evidence for confirming that the gravels on 40—50 m terrace of Tsientang River are deposited in an "estuary". And secondly we should look for the age of the terrace. HUANG and HSU mentioned that some stone implements have been found near Hangchow but unfortunately they turn to be historic artifacts. And the age of Siashu or Hsiashu loams, to which the Tsientang gravels may be correlated, is problematic. As suggested by HUANG and HSU the uplift of the sea coast might have taken place in "post-late-Pleistocene" (or we may say in Holocene time). It seems, however, that the sea level has been lowering down so deep as 40—50 m, since the Holocene time, is unlikely.

Further researches for the present problem are needed, especially in lower Yangtse valley and at other places along the Chinese coast. We should remind, moreover, the sinking of the Hopei Plain in North China. Perhaps it may help us to settle the present question. As to the question of glacio-eustatism as treated by HANSON-LOWE²⁵⁾ might have also something to do in connection with the present problem.

C) South China

In South China the Cenozoic geology is little known until the beginning of 1935, when a party of geologists, including TEILHARD, YOUNG, CHANG and myself, was sent by the Director of the Geological Survey of China to undertake a survey of Cenozoic geology in provinces of Kwangtung and Kwangsi²⁶⁾.

Sediments belonging to Pleistocene age in Kwangsi are: the yellow loams spread over the bottom of the valleys and on the top of 12 m terrace along the rivers; and a red drift spread over the slopes. Both the yellow sands and the red drift are not *lateritized*, as the extensive geological formation of "Lateritized Fan" of an earlier age (late Pliocene) does.

We have observed two kinds of cave deposits in Kwangsi: 1) the yellow deposits and 2) the shell-bearing cultural deposits.

From the yellow deposits in a cave in Hsingan district we have collected *in situ* the remains of *Ailuropus*, *Ursus*, *Hyaena ultima*, *Rhinoceros*, *Hystrix*, *Stegodon* etc.²⁷). This is evidently the same fauna well spread over South China, upper Yangtse, Indo-China, Burma, and Java. It is of lower Pleistocene age and contemporary to the cave deposits of Choukoutien in North China. But no fossil man has yet been recorded, except doubtfully in Indo-China by FORMAGET.

From the shell-bearing cultural deposits in a cave near Kweilin as well as those near Wuming, we have found a fauna of all living species and an industry, composing of decorated grinder, weight stones, crude side-scrapers, big choppers etc.²⁸). It has much affinities to the Neolithic finds in Indo-China, but we never discovered in these caves any polished object or other thing which might give us a hint to suggest a Neolithic age. As indicated by the strong mineralization of the fossils found together with the artifacts this industry might be of Mesolithic age, or even late Palaeolithic, as I have concluded.

From Yunnan province fossiliferous caves are known at very early date. YOUNG has studied a collection of Mammalian fossils from Hoshangtung Cave in 1932²⁹). Early in 1937 BIEN and CHIA made a special trip to Yunnan to re-explore the Hoshangtung cave and the Chiupei Rockshelter³⁰).

The fauna from Hoshangtung is composed of *Ailuropus*, *Stegodon*, *Simia*, etc. is evidently the same one as that of Kwangsi, just mentioned above, and consequently as that widely distributed all over South Asia.

The age of the *Ailuropus-Stegodon* fauna is, as we have repeated elsewhere, of lower Pleistocene age and contemporary to that accompanied with *Sinanthropus* in North China. It would be much helpful for us to correlate the Quaternary in China, in Java and in India as well, if we can execute an extensive research in Yunnan and the adjacent regions.

We have little to say at the present time so far as the Chiupei Rock-shelter is concerned. The fauna which we know now is poor. But it seems certain specimens are more mineralized than those collected from the Kweilin cave in Kwangsi and probably it is indicating that they are of an older age, late Palaeolithic. Two pieces of worked flint were found by BIEN together with many fragments of burnt bones and charcoals. This is pointing nevertheless the presence of human activity. As thought by BIEN and CHIA, the Chiupei Rock-shelter or the region may be the place where we may find the late Palaeolithic man or industry.

III) NEW RESEARCHES IN THE CHOUKOUTIEN REGION

New discoveries made in 1933—1934 in the Choukoutien region have been summarized in an article written by TEILHARD and myself³¹). Since then considerably important discoveries have been made and we may briefly note them under two following headings.

A) *Sinanthropus* Locality

Within Choukoutien region there are many fossiliferous localities which we have designated by numbers. Only from Locality 1 we have recovered the remains of *Sinanthropus* and consequently we often call it as *Sinanthropus* Locality.

A continuous excavation has been carried on by Mr. L. P. CHIA in 1935 to 1937, when I was absent from China. Beside many other important finds of fragmentary materials of the most primi-

tive man in China, Mr. CHIA discovered successively in 1936 three skulls, crushed into numerous fragments but easily to be reconstructed.

A brief account on the three new skulls has been published in "Nature"³²) and a more detailed one on all the newly found materials appeared in Bulletin of Geological Society³³). All the three skulls belong to adults, as affirmed by WEIDENREICH, the well known German anthropologist now undertaking the investigation of the *Sinanthropus* materials in Peking. The brain capacity of the largest skull (Skull I of Locus L) is estimated about 1,200 c.c., while that of the smallest of the three (Skull II of Locus L) about 1,050 c.c. And the medium sized one (Skull III of Locus L) has a brain case about 1,100 c.c.

With regard to the morphological characters of the newly recovered skulls it is found that they are of the same features as the skull I (Locus E) described by BLACK but more pronounced in certain characteristics, such as the size and the thickness of the supraorbital ridges and the occipital torus, the crest of the vertex and the muscle markings of the temporal bone (Fig. 2).

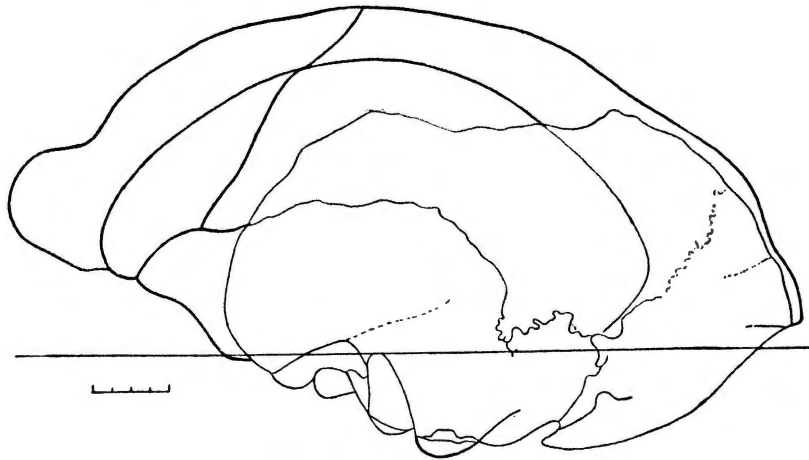


Fig. 2. Graphic reconstruction of the left norma lateralis of *Sinanthropus* Skull III of Locus L on the basis of the left temporal bone H III in Frankfurt orientation. 1/2. (after WEIDENREICH).

In comparison with the human fossils, WEIDENREICH found that there is no appreciable difference between *Pithecanthropus* and *Sinanthropus* so far as the general shape and the lowness of the skull cap are concerned. However, by two characters the German anthropologist thinks that he can differentiate the Java and the Peking man. The first one is that in *Sinanthropus* the frontal bone is more vaulted than in *Pithecanthropus* and the second is that the supraorbital ridges of *Sinanthropus* are separated from the forehead by a really broad furrow, while in *Pithecanthropus* they continue gradually to the brow (Fig. 3).

Considering the presence of "torus mandibularis" on the inner side of the mandibles and the occurrence of the "shovel-shaped" incisors WEIDENREICH was convinced that there is some direct relationship between Peking Man and the Mongol races of the recent mankind.

Early in February of this year (1938) when I have resumed my Laboratory work in Peking after two years' study in Europe, I found, among already sorted masses of fragmentary bones, one small piece of femur which, it seems to me, belongs to no other animal except *Sinanthropus*. Later finds of the same long bones, more complete and better preserved, let us to believe that they are undoubtedly coming from *Sinanthropus*. Since then the long suspected question as the absence of long

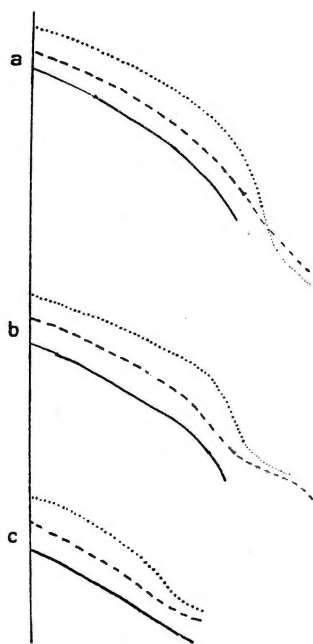


Fig. 3. Comparative sagittal outlines of the frontal bones of *Sinanthropus* Skull VI (—) newly discovered, Skull I (....) described by BLACK and *Pithec-anthropus* (----). a, curves of the midline; b, curves in the middle between (a and c); c, curves in the level of the anterior end of the inferior temporal line. Reduced one-half (after WEIDENREICH).

Locs. 9 and 13 *Euryceros* is the most characteristic one for this horizon and different from the same group of deer known as accompanied with *Sinanthropus* from Loc. 1. Another Mammal, *Siphneus tingi*, which is well known in North China in the Sanmenian deposits (Sanmenian I of later sense), is abundant at these two localities and we may explain, it is but a survived form from Pliocene.

It is extremely interesting to note that we know one piece of chert of undoubtedly human origin³⁷). It was made from an older nodule and fashioned by heavy blows by free hand flaking.

Lower Pleistocene. In the Choukoutien region many localities, including that of *Sinanthropus*, are of lower Pleistocene age. Fossil man, stone implements, and other mammalian fossils were found abundantly in Loc. 1, as noted above.

Middle Pleistocene. A memoir of mammalian fossils from Loc. 3 of the Choukoutien region was published in 1936³⁸). As concluded from the palaeontological study, I inclined to think that the present Locality is somewhat younger than the *Sinanthropus* one, as being proved on one hand

bones of Peking Man is now settled. Up to now, (May, 1938) we have encountered: six femora, one humerus, one radius, one ulna and one fibula. Unfortunately none of them is complete but only badly broken.

The femur of *Sinanthropus* as studied by WEIDENREICH³⁴) bears some characters allied to both the recent and fossil man known before but no similarity to the great apes.

Mr. CHIA's work at Choukoutien is also greatly contributed to the archaeological study of the *Sinanthropus* site. He found during the last three years numerous well fashioned stone implements. My impression, as well as that of TEILHARD, on the new prehistorical materials, after a first glance, is that from the upper levels of the Locality the small flakes of quartz are abundant; and that, on the other hand, in the lower part of the deposits the big sandstone implements roughly made from river gravels are dominant.

The various types of both quartz and pebble-making implements are still those already recognised some years ago³⁵) and practically nothing is new, except the big flakes of triangular shape better retouched than what we knew before.

As to the bone implements attributed to the work of *Sinanthropus* an elaborate memoir written by Prof. H. BREUIL is now in press. He noticed several types and certain techniques employed by the ancient man. A summarized work has been appeared in "Antiquity"³⁶).

B) Fossiliferous and Archaeological Sites other than Loc. 1

The research work in Choukoutien region is not limited to Loc. 1 or the *Sinanthropus* Locality but also devoted much time to the study of environs. Up to the present we know in various localities practically all the horizons linking from lower Pliocene up to very late Pleistocene.

Basal Pleistocene. Locs. 9 and 13 have yielded fossils of very early Pleistocene time^{37, 38}). Among the mammalian remains from

by the absence of the most typical lower Pleistocene Mammals and on the other hand by the presence of a great number of living forms. It should, therefore, if I am correct, represent the time interval between lower (*Sinanthropus* Locality) and upper Pleistocene (Upper Cave).

Another new Locality, designated as Loc. 15 of Choukoutien, was excavated in 1935 to 1937. We found a great quantity of stone implements but together with a poor fauna. The Loc. 15 implements seem to be better worked than what we know from Loc. 1. They are composed of well retouched flakes of big size, carefully trimmed "points", good triangular flakes without secondary work, etc. (Fig. 4). Most of them are made of sandstone, chert and flints. As to the quartz tools, there is no observed difference from those collected from Loc. 1, with the exception that from Loc. 15 so far we did not find the so-called "bipolar" flakes and implements, which are the most typical artifacts abundantly used by *Sinanthropus*.

From the archaeological view of point we may say without hesitation that the Loc. 15 industry is more advanced than that of *Sinanthropus* and consequently it might well represent the Middle Palaeolithic in China⁴⁰).

From palaeontological study it helps us but little for such a suggestion. However some upper and lower jaws of a typical form of *Rhinoceros tichorhinus* (large size) are found recently in this locality. This form is well known in Sjara-osso-gol, which we suppose, is the contemporary facies of Loess in Ordos (Middle Pleistocene). And another fossil, *Siphneus fontainieri*, so far we regarded as the type fossil in Loess in North China, is also known from the present locality. It seems to me a later age of Loc. 15 deposits is quite favorable. If so, Locs. 3 and 15 are the representatives of Middle Pleistocene and Middle Palaeolithic of China both from palaeontological and archaeological point of view.

Upper Pleistocene. On the top of *Sinanthropus* Locality hill there is one cave for which we have named as "Upper Cave" of Choukoutien. It is entirely separated from the deposits of Lower Pleistocene age and was excavated in 1933 and 1934. A preliminary report on the important finds has been published⁴¹).

The fauna found in "Upper Cave" is composed of many living forms and some extinct or migrated species. They are, on the whole, of very late appearance but undoubtedly of Pleistocene. Together with the late Pleistocene fossils we have collected four skulls and other materials of fossil man which evidently belongs to *Homo sapiens*. The lithic industry in the present cave is rather poor. Only one side-scraper in flint and some pieces in flint and quartz were found. But the bone, shell and antler making tools are relatively abundant, including bone needles, perforated teeth, perforated



Fig. 4. Big flake-tool from Loc. 15 of Choukoutien

stone-pebbles and polished antlers of deer. The industry is obviously corresponding to the upper Palaeolithic (Magdalenian?) in Europe.

IV) PROBLEMS OF CORRELATION OF QUATERNARY IN CHINA AND EUROPE

In the past few years we have devoted much time in attempting to make a correlation of Quaternary in China and Europe. TEILHARD has published his opinion⁴²⁾ and I have written what I am able to do, basing upon our present knowledge⁴³⁾.

Concerning the correlation of Quaternary in Europe and China what we are sure is that, there are two series of deposits in common in these two continents: 1) one is older and consists chiefly of gravels and sands and covers the period from late Pliocene to the early phase of Pleistocene; and 2) the other is younger, consists mainly of loessic materials and covers a later phase of Pleistocene. Stratigraphically, lithologically, and faunatically, these two series can be correlated with cer-

General		Europe				China		
Chronology	Industry	Cycle of Changing climate	Fossil man	Industry		Geological sequence	Fossil man	Industry
				Biface	Flake			
Pleistocene	Holocene	Neolithic	Homo sapiens	Neolithic Mesolithic				
	Upper Pleistocene	Upper Palaeolithic	Homo Sapiens fossilis	Upper Palaeolithic	Lev. VII	Upper Cave of Choukoutien	Upper Cave man of Choukoutien	Upper Cave Industry of Choukoutien
			Homo neanderthalensis	Magdalenian	Late Levelloisian Lev. VI			
			Grimaldi	Solutrean	Micocquien Lev. V			
			Crô-Magnon	Aurignacian	Moust. Lev. IV	Sandy facies of Loess at Sian-ssou Gou in Ordos	The Ordos tooth	The Ordos Industry
			Neanderthaloid (early form)	Moust. Ach. VII	Micocquien Lev. V			
			Krapina	Ach. VI	Middle Levelloisian Lev. IIIb	Loess	?	
			Ehringsdorf	Ach. V	Tayacian II			
			Swanscombe (?)	Ach. IIIb	Early Levelloisian Lev. III			
			Steinheim	Ach. IIIa	Tayacian I	Loess	?	
			Ach. II	Clactonian III				
			Ach. I	Clactonian II	Locs 3 & 15(?) of Choukoutien		Loc. 15 - Industry of Choukoutien?	
				Clactonian I	Loc. 1 (or Locality) of Choukoutien	Sinanthropus	Sinanthropus Industry of Choukoutien	
					Loc. 13 of Choukoutien		Loc. 13 Chert implement of Choukoutien	
Pliocene		Cold Period 1	Unknown			Sanmenian (Nihowan)		

A proposed Correlation-table of geology, fossil man and prehistory in Quaternary period in Europe and China.

tainity. But going any further or more into detail than this, must come under the heading of suggestion or working hypothesis.

TEILHARD suggests a correlation can be made through South China and India by means of glaciations which are known both in Europe and India or through the region of Sinkiang (along the foot of Tienshan) and Ordos by means of terraces and loessic and fan deposits.

I have tried by means of palaeontological, palaeo-anthropological and prehistorical basis and compared furthermore the physiographical stages recognized in China with the glaciations well developed in Europe. My suggestion may be summarized in the table on page 130.

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