THE PAOTE AND CHINGSHUI PHYSIOGRAPHIC STAGES AND THEIR SIGNIFICANCE.

by

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Summary. Reasons are given for the introduction of two new stage-names in the series of steps by which the present land-surface has evolved. The term *Paote Stage* is proposed for the long-recognized phase of aggradation (between the Tanghsien and Fenho erosional stages) during which the Red Clays and high gravels accumulated. The importance of the *Chingshui Stage* has not previously been appreciated, but it is now clear that an epoch of erosion separated the Sanmen and Malan (loess) Stages of accumulation. When Dr. Andersson first applied the term Fenho Stage to the dissection seen in the Chaitang Basin*, Dr. V. K. Ting had not yet discovered the Sanmen beds**. With the recognition that these beds were not an isolated deposit but represented a distinct change of conditions which left its mark widespread over Northern China, it became necessary to establish the exact relationship between the Sanmen and Fenho in Willis's type area.

It seemed probable from a study of the Kalgan Area*** that there were episodes of trenching both before and after the Sanmen Stages, but conclusive evidence was not to be found in that district.

With a view to settling these questions, I revisited the type locality where the narrow gorges of the Fenho separate the fertile upper and lower basins of Central Shansi. I had the particular good fortune to have as companion Father Teilhard de Chardin, whose methodical studies of the Tertiary and Quaternary deposits of North China have greatly clarified our understanding of the more recent stages in the evolution of the present land-surface.

On approaching the gorges, the ancient highway to the west—followed by Marco Polo and many famous men before and since—keeps to the higher

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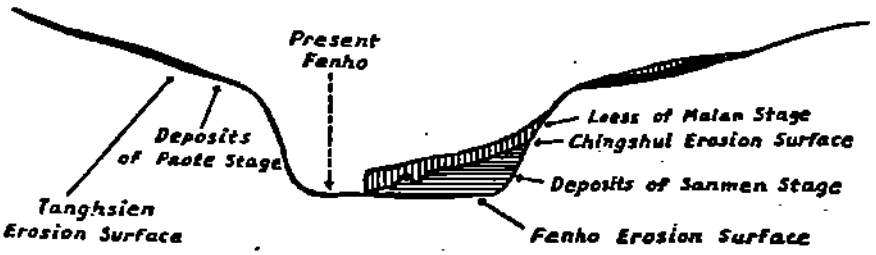
* L. F. Yih. Geology of Hsishan; Geol. Surv. China Mem. A1, 1920, p 68.

** J. G. Andersson, Essays on the Cenozoic; Geol. Surv. China Mem. A 3, 1923, p. 117.

*** G. B. Barbour, Geology of the Kalgan Area; Geol. Surv. China, Mem. A 6, 1929, p. 109.

slopes. But by skillful engineering the new arterial motor road has been driven for several miles right through the heart of the gorge. Hence sections are now easily accesible that were denied to Marco Polo and Bailey Willis.

Both Sanmen deposits and Malan loess occur right in the bottom of the canyon. Hence the Fenho must have cut its channel practically down to its present depth before either deposit formed. Careful study of the character of the basal contact of the loess shows that the latter deposit lies on a sharply dissected erosion surface which in places trenched the Sanmen-beds down to the present stream level (see Fig 1.). This stage of erosion separating the



Sanmen and Malan epochs of accumulation may be referred to as the *Chingshui Stage* since the lowest rock terraces flanking the Ching Ho in the Hsi Wan Tze Pass just outside the Great Gate in the Wall at Kalgan (Chang Chia Kou) were incised at that time.

The rejuvenation responsible for the erosion was primarily due to a climatic cause, but along stretches of the Yellow River and elsewhere in northern Shansi and Hopei the effects of tectonic forces were also superposed. North of Pao Te, for instance, the base of the Sanmen Series lies high above the base of the loess*, whereas downstream at Tung Kuan both formations can be seen extending right down to the present level of the river, a relationship only adequately accounted for by warping of the surface. The same appears to be the case in the gorge at Kalgan where the terrace on which the basal gravels of the Sanmen Stage lie stands 60 feet above the present floodplain, while the loess extends down to near the bottom of the gorge (see Fig. 2).

The other term proposed, *Paote Stage*, is needed to cover the period of accumulation which followed the Tanghsien erosion, corresponding to the distinctive names (Sanmen, Malan) given to the two following epochs of

* see Teilhard and Young, Pre-loessic and post-Pontian formations in Western Shansi; Geol. Surv. China Mem. A 8 (seen in manuscript)

deposition. When the only certain representatives of this epoch were small scattered deposits of Hipparion clay, they might have been only shallow local flood-plain sediments belonging to the full maturity of the Tanghsien erosion cycle. But with the recognition of the fact that the Pontian Red Clays and associated early Pliocene fresh-water sediments were spread far and wide over the country so as to attain the importance of a formation, it has become desirable to a general name for the epoch which began with the accumulation of deposits upon the Tanghsien erosion surface and ended with the Fenho rejuvenation.

The name here proposed, *Paote Stage*, is chosen because of the very extensive development of deposits of this epoch recently described by Teilhard and Young from near the city of that name in western Shansi.*

One advantage of such a term is that while it includes sediments of Pontian age it is not restricted to that horizon. The other term at present in use is Red Clay, the formational term applied by Andersson**. But though extremely useful in practice for deposits of that lithological character, it cannot be extended to river-sands and coarse boulder deposits which occupy the same stratigraphic position and conform to the same topographic subsurface. In addition the term covers all deposits of pre-Fenho age clearly resting on the Tanghsien erosion-surface, wherever the latter is recognized, without requiring that an exact date be assigned to them—which, in view of uncertainty still existing as to the exact limits in time of the various stages, is a distinct asset. It is not suggested that in actual duration of time the stage of accumulation ranks as equal with the preceding erosion. The fully mature character of the surface on which the deposits formed implies that denudation had been the order of the day for a protracted period before any of the now extant clays and gravels began to collect.

It is a common place that on continental surfaces erosion and deposition may go on contemporaneously in different parts of the same drainage system so that the Tanghsien and Paote Stages unquestionably overlapped in time. But the mere fact that recourse has to be had so constantly to lithological names for the formations of this and the following epochs shows that no apology is needed for introducing such a term now that the importance of the deposits and of the stage they represent has been established.

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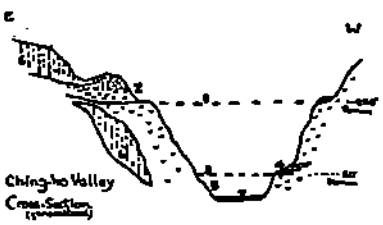
* Teilhard and Young, op. cit.

** J. G. Andersson, op. cit.

A further justification for the introduction of these new stage terms is that they seem to fit the facts where applied in other areas than those in which they were first used. In his early study of Chaitang Basin in the Western Hills, Andersson drew attention to dismembered sand and gravel deposits perched high on the spurs of the mountain ranges clearly conforming to the original Tanghsien erosion surface long since isolated by the Fenho dissection. These I regard as belonging to the Paote Stage. While right down near the point where the Hunho debouches onto the plain at Men Tou Kou careful study shows that the twisting valley is an incised meander entrenched to its present depth in Fenho times and thereafter slightly widened before being aggraded by deposits of Sanmen age. These in turn are overlaid by loess, but the contact is one of sharp dissections—clearly the counterpart of the Chingshui erosion.

In all we have record of five erosion cycles, four of them followed by epochs of aggradation. The revised order of stages will be clear from the cross-scetion of the type locality shown in Fig. 2, which however does not include the early Tertiary Peneplane of the summits.



0 Peitai Peneplane.
Basalt lavas
1 Tanghsien erosion surface
2 Paote Stage gravels
3 Fenho erosion surface
4 Sanmen Stage gravels
5 Chingshui erosion surface
6 Malan Stage loess
7 Panchiao erosion
Present floodplain

Fig. 2