THE AGE OF THE BASALTS OF CHINGHSING

By GEORGE B. BARBOUR

Department of Geology, Yenching University

The Chinghsing coal-basin lies on the Chengtai Railway some 35 miles (57 Km) from Shihchiachuang. Trains to Taivuan stop there an hour-and-a-half after leaving the junction of the Peiping-Hankow main line.

In reporting on the geology and ore-deposits of the district, Chu and Li* described outcrops of basalt lava overlying eroded pre-Jurassic sediments. A variable layer of red clay is usually present interposed immediately beneath the lava, and is often found baked by the heat of the latter.

Dr. V. K. Ting, at that time Director of the National Geological Survey, recognized the significance of the structural relationship and thermal metamorphism of the red beds. Search instigated by him yielded a number of small gastropods recently described by P'ing in Palaeontologia Sinica.**

C. C. Wang, who collected the fossils, has recently given a report*** of a detailed study made in 1927, illustrating it with excellent structure-sections and discussing carefully some of the problems involved.

In their clear and serviceable outline of the geology along the Chengtai Railway,**** C. T. and Y. L. Wang have also described in detail the structure of two of the basalt-capped hills overlooking Chinghsing. Like Mr. C. C. Wang, they assign a late Pliocene or post-Pliocene date to the basalts; they connect the lavas with local faulting which is therefore given a correspondingly late date.

A snow-storm in December 1930 deranged the train service and gave me a chance to make a brief visit to Chinghsing. Visibility was poor, so that certain aspects of the topographic situation—especially the relationship of the basal contact surface of the basalts to the crestline of surrounding summits—could not be observed. But enough was seen to make me question the validity of certain inferences based on conclusions made before the stages of evolution of the North China land-surface were as thoroughly understood as they are today.

*Bull. Geol. Surv. China No. 6, 1924
**Pal. Sin. Ser. B, Vol. VI, Fasc. 5, 1930
***Bull. Geol. Surv. China, No. 15. 1920 p. 119-124
****op. cit. p. 53-118

The purpose of the present note is to urge caution in setting an age even as young as early Pliocene to these effusives which are coming to be generally accepted as evidence of a later episode of volcanic activity than has been recognized elsewhere in the region, and hence to imply an igneous and diastrophic history which seems out of keeping with that of the rest of the area and not fully in accord with the physiography of the locality. I believe that the youthfulness of the basalt has been unduly exaggerated and that there is at present no adequate ground for insisting that the Chinghsing basalts are materially younger than the other Middle Tertiary (Miocene) outbreaks of the region.

STRATIGRAPHIC ASPECT OF THE PROBLEM.

The alternative view in favour of a younger date is clearly stated in the two recent papers cited above. The attack on the problem is made from a different angle in each case. Messrs. C. T. and Y. L. Wang dwell on the stratigraphic aspect, Mr. C. C. Wang emphasizes the physiographic and structural sides of the situation.

In view of the clearness with which the field-evidence is set out in Mr. C. C. Wang's paper—which unfortunately had not appeared at the time of my visit—little need be added on this score.

Cappings of basalt—clearly dismembered remnants of once continuous lava-flows—crown three summits overlooking the Mienho valley, a bend of which isolates Hsuehhuashan from the other two, Tungyaoling and Hung-t'unao. The basalt rests directly on Ordovician limestone at the latter point, but elsewhere its contact with the Carboniferous and Permian is usually marked by a wedge of the clay formation. This varies in texture from point to point, being a complex of gravel, sand, silt and earth with an admixture of medium-grained and fine angular detrital material, the whole of a brick-red to red-grey colour, often well-cemented and locally strongly indurated by the heat of the lava. Thick layers of calcareous concretionary material appear in several exposures, evidently old hardpan horizons. It is from this formation that the molluscan fossils were obtained.

In dating the red clay formation, the authors of the Chengtai report say "The basalt rests on beds of red and conglomerate which we have reason to assume to be the oft-mentioned Hipparion formation. The basalt has certainly been erupted through faults in this region and the formation of these has consequently taken place in post-Pliocene or may be late Pliocene time." (p. 91).

The argument clearly turns on the assumption that the red-clay under the basalt is necessarily of Pontian age. But the identification is based only on its lithological similarity to supposed Pontian clays elsewhere in Shansi, whereas the latter in many cases present problems of identity that cannot yet be regarded as solved. For instance, the bulk of the red-beds along the railway in the Shouyang basin (65 miles nearer Taiyuan), which are cited as among the best examples of thick developments of Hipparion clay, appear to be of distinctly younger (Sanmenian) age. It is not unlikely that red beds of very similar appearance will eventually be found in different localities representing every period from Eocene to Pleistocene. Red clays older than late Miocene seem usually to have escaped erosion only where they have been down-faulted below the local base-level of erosion. But a capping of basalt would have exercised the same protective effect and in the Chinghsing instance this possibility must not be overlooked.

No mammalian remains have been recovered from the Chinghsing red clay so that even the provisional dating as "Hipparion" seems risky. The only fossils discovered were those of the freshwater mollusca described by P'ing, of which four out of five are new species and the fifth is not diagnostic. Even granting the relativelv modern character and fresh appearance of the shells, our knowledge—as Dr. P'ing himself points out—is still too fragmentary and ill-defined to warrant such exact dating as has been assumed in this case.

Younger basalts are known from within the extreme northern limits of the province and in Mongolia. All we wish to insist on here is that viewed stratigraphically, in the absence of more exact criteria in the matter of mollusca as horizon-indicators, a post-Miocene age for the Chinghsing basalts is "not proven".

Structural and Physiographic Aspects of the Problem.

In view of the uncertainties connected with the purely stratigraphic attack on the problem, the structural and physiographic aspects become the critical ones.

If the lower contact surfaces of the basalt are connected up, as is done in Mr. C. C. Wang's ingenious diagram, the impression is given on a gentle depression which resembles the kind of relief associated with the erosion surface produced during the Tanghsien Stage. At the same time it must be remembered that the relationship of the basalt to the faulting is not known; the two are probably causally connected but the feeder of the lava-flows has not been identified nor has the succession of events established. Even if the basalt came up a fissure along a recognized fault-line which has for some reason escaped discovery, very slight movement along revived fault-lines after the eruptions would be enough to produce the present differences in the elevation of the contact.

Dr. W. H. Wong places the upper limit of the Middle Tertiary crustal movement for North China in late Oligocene or Miocene. Both the papers dealing with the Chinghsing basalts suggest a Pliocene date for the faulting.

It is readily granted that post-Pontian movements of two types are called for to explain certain features of Shansi geomorphology. For instance, differential uplift by warping is alone competent to explain the present relative positions of Tertiary and Quaternary stream deposits at various points along the banks of the Yellow River or of the superficial formations in the gorges of the Fenho. Similarly, very late Pliocene or post-Pliocene faulting is needed to account for the "hanging" position of Sanmenian fluvio-lacustrine deposits abutting the great Taiku fault-scarp overlooking the Taiyuan plain.

But careful physiographic study of the Mienho valley from below Chinghsing to Yangts'un, a distance of over 35 miles, shows a consistency of history that extends back at least as far as Middle Pliocene. The Panchiao, Malan, Sanmen and Fenho stages are all well-represented by rock platforms, non-accordant tributaries, or terraced and dissected deposits of gravel, loess and alluvium. At Chinghsing the Fenho erosion seems to have cut at least as deep as the base of the present river bed. Mr. C. C. Wang recognizes the dissection of the basalt as being at least as old as the Fenho Stage of dissection. Recent observations have shown that, although questions of identification and correlation are involved, the Fenho Stage *sensu stricto* (as defined by the topography of the Fenho gorges where the term was first applied by Willis before its adoption by Andersson) occurred before Sanmenian times, that is to say falls essentially within the Pliocene Period.

Thus, although the main Chinghsing fault-lines exert strong topographic influence, I find it hard to reconcile so recent a date as late Pliocene with the interval of time needed to remove all post-Ordovician sediments from the up-throw side of the fault-block, or with the extensive dissection which has cut right through the basalt, stripping it from its hard rock floor and leaving only a few small widely scattered outliers perched on eminences overlooking steep declivities down into a broad valley which has been entirely cut to a depth of over 330 feet since that time. Although some movement very probably did occur right at the close of the Tertiary Era along old revived faultlines, the major rupture must have been very early in the Tanghsien stage and quite possibly right at its opening. In any case, a Miocene date for the faulting appears consistent both with the revised age-limits of the basalts suggested above and with the physiographic evidence.

CONCLUSION

Hence, until more definite palæontological data make it clear that the red clays at Chinghsing are at least as young as early Pliocene, it is suggested that there is as yet no adequate ground for giving to the vulcanicity and associated faulting in the locality a different and much younger date than that indicated for other localities in this section of North China.