# THE DEVELOPMENT OF THE UPPER YANGTZE VALLEY

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## General Features.

The Upper Yangtze valley includes the valleys of the main river and its chief tributaries. Chinshachiang (金沙江) and Yalungchiang (雅礱江) flow in north-south courses through Hsikang, Eastern Tibet, and turn to NEE below the confluence at the border of Szechuan and Yunnan provinces. The Minchiang (岷江) and Chialingchiang (嘉陵江) in Szechuan basin run likely from north to south and enter the Yangtze at Ipin (宜賓 or Suifu 叙府) and Chungking respectively. Contrarily, the Putuho (普渡河) in Yunnan and Chienchiang (黔江) in Kueichow and S. E. Szechuan flow to the Yangtze from south to north. The main valley of Yangtze itself is generally in a SWW-NEE direction and cuts the beautiful gorges above Ichang which constitute the most attractive scenery to the traveller who passes through this region (fig. 1).

Dealing with the formation of the gorges, geologists[1] hesitated between the opinions of antecedent and the connection of waterheads of two consequents. Bailey Willis[2] suggested that the valley is antecedent on account of no evidence of the uniting of watersheds of small consequents through the anticlines of the gorges. On the other hand, that the valley on the western side of Huangling anticline was once a consequent stream is however believed by Prof. J. S. Lee[3] based on his finding of the Yaotze conglomerate at Sintan which dips at 10 degrees to NW.

In the lower stream of Chialingchiang, 30 to 50 km. in straight line above Chungking, there are three other gorges formed by three anticlines

1 Abendanon, E. C. Structure geology of the Middle Yangtze-kiang gorges. Chicago Jour, of Geol. Vol. XVI, No. 7, pp. 612-615.

2 Willis, B. Research in China, Vol. I, pp. 334-336.

3 Lee, J. S. Geology of Yangtze gorge. Bull. Geol. Soc. China, Vol. III, pp. 382-389.

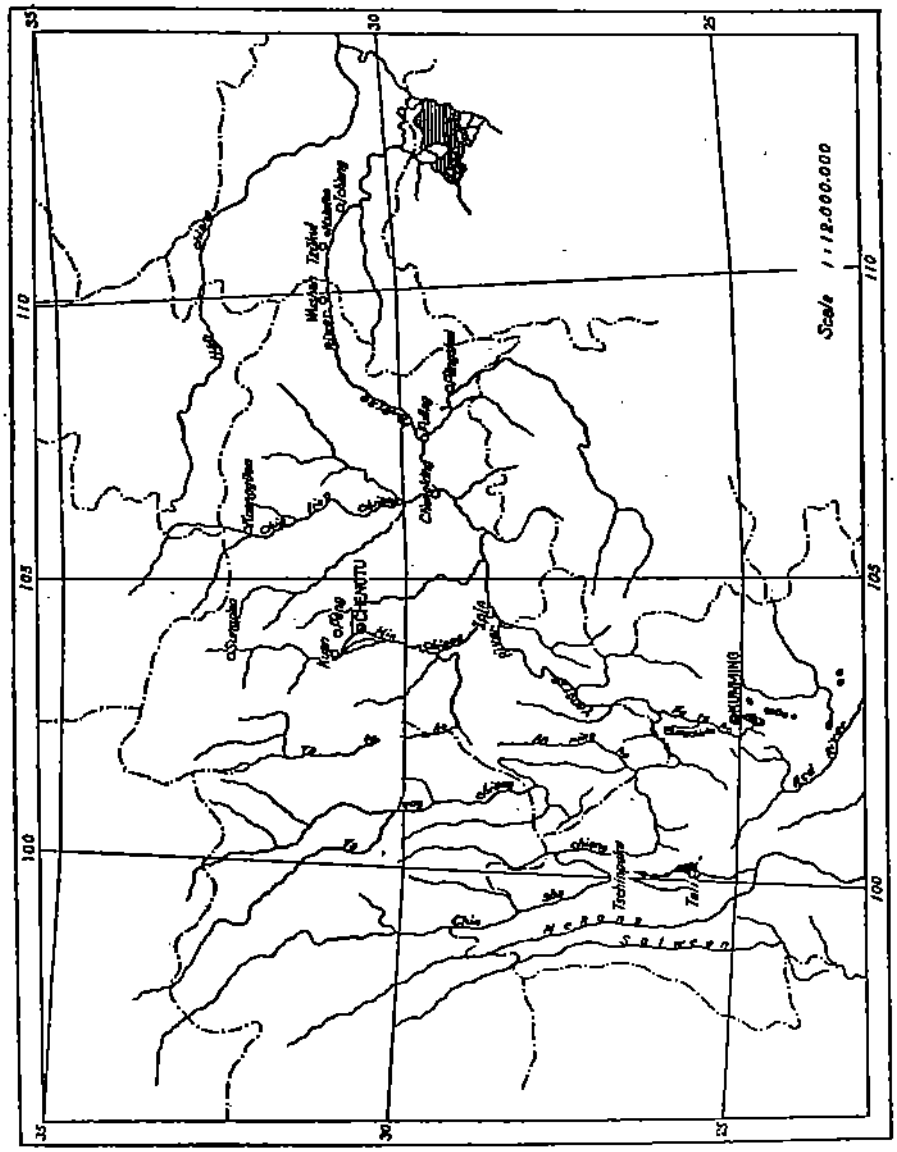


Fig. 1 Sketch map showing the Drainage System of Upper Yangtze Provinces.

(fig. 2). If there the valley is considered to be formed by the connection of waterheads of two consequents, it should be first assumed that there were three pairs, at least, of consequent streams on the inclined limbs of the anticlines. Then successively the water-heads of those streams should have united together pair by pair to form a single valley. But there are several objections to this theory: firstly it seems to be a very rare case that the three pairs of consequents just lay in one line as the present valley is; secondly the anticlines are so close together in which the consequent streams would be not longer enough to carry a strongly dissecting power. On the other side because no younger deposit has been found and is likely to have been covering on the folded strata, the valley can not be said to be of superimposed origin. Therefore the lower Chialingchiang valley is believed to be an antecedent river.

Most probably the same explanation is applicable in the canyon-like valley of Yangtze above Ichang.

On the west, in Western Szechuan and Eastern Tibet, the valleys of Chinshachiang, Yalungchiang and Tatuho (大渡河) etc. are almost in north-south direction parallel with the tectonic features and have been excavated to a great depth. They are therefore unquestionably longitudinal consequents.

The development of the upper Yangtze valley which is different in types from east to west, can best be described in three major stages, for which the nomenclatures of the Basin stage, the Tsingling stage and the Yangtze stage are proposed.

### (1) The Basin Stage.

In the Cretaceous time the central part of Szechuan province including Kueichow (酆州) of W. Hupeh was surrounded by high lands forming an inland basin among them. The basin received the deposition of red beds (fig. 2) and from the high lands arround it the materials of sediments were chiefly supplied.[1]

The Tunghu series, in the environs of Ichang, may also be considered as Cretaceous deposits equivalent to the red beds of Szechuan province and the Kueichow series of the gorge districts although it is regarded as of Early Tertiary

1 Prof. Grabau considers that the material was derived partly from Tsingling and partly from the old land of Tibetia on the west. "Migration of Geosynclines" Bull. Geol. Soc China. Vol. III, p. 293.

by Prof. J. S. Lee[1], Messrs. C. Y. Hsieh and Y. T. Chao[2]. Their rock characters appear to me almost alike. Moreover it seems impossible that 3,500 m. of Cretaceous strata were entirely eroded away and redeposited in a new formation of Tunghu series in Early Tertiary within a distance of only 80 km. The two basins might be, however, separated by a slightly upwarped Huanglingmiao bar in Early Cretaceous time.

Along the northern margin of Szechuan basin, conglomerate beds were found at Kuangyuan[3] (廣元) Penghsien (彭縣) and Kuanhsien (灌縣) indicating that there were numerous streams which brought the pebbles coming from Tsingling. Of such streams were probably originated the ancestors of the rivers Minchiang and Chialingchiang. Likely the other sides of the basin were also drainaged by ancient streams flowing to the center of the basin except the eastern side where the Huanglingmiao land surface was not much higher than the basin. This can be shown by the closeness of the Kueichow series on the west and Tunghu series on the east.

Up to the end of Cretaceous time the basin was almost filled up with red beds which were probably connected with the Tunghu series of the eastern basin[4]. As no younger deposit has been found lying upon the red beds other than the Pleistocene gravel, it evidently shows that the land surface was uplifted and subjected to erosion in Early Tertiary. The rivers on the uplifted red-beds then flowed to east on the way upon the surface of Tunghu series. The drainage system in that age can thus be inferred from the distribution of red-beds. The course of the old Yangtze valley was thus laid down (fig. 2).

Since no evidence of water outlet can be found in any other locality of Szechuan basin it is difficult to say that the river had ever flowed to the west.

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1 Lee, J. S. op. cit. p. 382.

2 Hsieh, C. Y. & Chao, Y. T. Geology of Ichang and neighbouring districts. Bull. Geol. Surv. China. No. 7. pp. 66-67.

3 Chao, Y. T. & Huang, T. K. The Geology of the Tsinglingshan and Szechuan. Mem. Geol. Surv. China. Ser. A, No. 9. pp. 91-92.

4 The Tunghu series was formerly regarded as the same as Kueichow series by Willis and Blackwelder in "Research in China" Vol. I, p. 278, and also considered by Abendanon as equivalent at least to the upper part of Kueichow formation "La Geologie du Bassin Rouge" pp. 163-164.

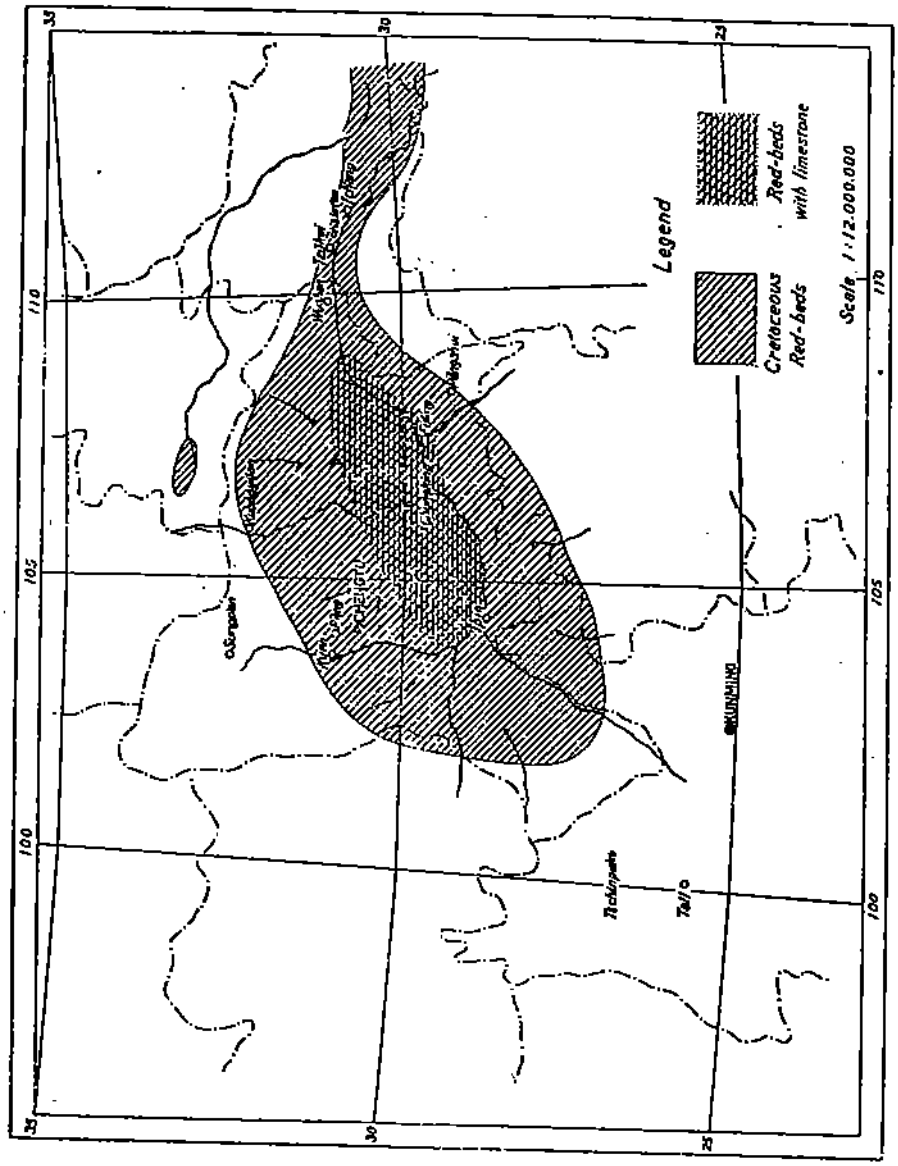


Fig. 2. Sketch showing the Drainage System in the Basin stage.

The Yaotze conglomerate[1] which is held by Prof. Lee to indicate that the river of Wushan region had flowed to west in Early Tertiary, was probably deposited in later age when the valley has already been formed. And the pebbles of the conglomerate were brought out by the Lungma river, which runs from north to south through Huangling granite and its successive strata.

### (2) The Tsingling Stage.

There seems to be no evidence in upper Yangtze provinces to show that the last orogenic movement happened earlier than Cretaceous time, it is at least likely that the mountain making was due to the Nanlingian of Mid-Tertiary age[2]. The anticlines in the gorge district as well as in the Szechuan basin were thus folded up in a prevailing axial direction of NE and SW. During the process of folding the degradation work of the ancient Yangtze went on contemporaneously in the course which was formerly laid down. As result of the degradation a young mature valley was formed with a depth of about 600 m. below the hills which bounded it. The valley bottom is now at 600 m. above the river level as can be recognized in the Yangtze gorges. Willis[3] designated this phase of the cycle of erosion the Tsingling stage.

The topographical aspect of the above mentioned stage is fairly recognizable in Chienchiang between Pengshui (彭水) and Fuling (涪陵) where a rather wide mature valley appears above the narrow canyon at about 300-400 m. above the present river level. In lower Chialingchiang region although the valley is also believed to be antecedent but very little ancient topography can be seen. The surface of Tsingling stage is thus not identifiable there. On the N. W. corner of Szechuan, the gentle slope surface in the environs of Sungpan (松潘) of upper Minchiang valley probably represents the Tsingling stage at an altitude of 3,200-3,500 m. above the sea.

We now turn to the western regions in Yunnan and Hsikang where the folded strata were again complicated with faults. Both folds and faults are

1 Lee, J. S. op. cit. p. 382.

2 Wong, W. H. Crustal movement and igneous activities in Eastern China since Mesozoic time. Bull. Geol. Soc. China, Vol. VI, pp. 23-26.

3 Willis, op. cit. p. 336

in the direction of N-S or NNW-SSE[1]. According to Deprat[2] the fractures in Yunnan happened in Late Pliocene time. The remarkable faults which traverse the plateau of Eastern Hsikang were most probably formed at the same period.

Upon the fluted surface, longitudinal consequent rivers flowed from north to south. Of these consequents the Salween or Luchiang and Mekong or Lantsangchiang flow in N-S courses and remain unchanged up to present time. While the Chinshachiang and Yalungchiang which now flow to east after joining together might have been formerly parallel with the preceding streams and independently run through Yunnan southward.

The watershed at Tschin-pu-ku between Chinshachiang and Yangpiho in NW Yunnan is 600 m. above the river level of the former (fig. 3). South of the saddle there is a long valley leading to Chienchuan (劍川). Several lakes situated in the valley as far south as to Talifu are all at similar altitudes of 2,521, 2,358, 2,342, 2,341 and 2,174 m. from north to south respectively, while the saddle itself is slightly higher at an altitude of 2,612 m. Further south passing through a 2,500 m. watershed there is the head of Red River which flows southeastward to the Gulf of Tonking[3]. As already mentioned, the old valley is about 600 m. higher above the present river in the Yangtze gorge, it is quite reasonable to think that the line joining the saddle of Tschinpuku, the valley of lakes as well as the Red River represents the ancient valley of Chinshachiang in the age of Tsingling stage. Gregory[4] made the same assumption that the Chinshachiang has formerly flowed through the wind-gap (Tschinpuku) to the basin of Kienchwen (Chienchuan) and thence discharged through the Red-River to the Gulf of Tonking. Wonderfully the local tribe has a tradition that the Yangtze once flowed through that gap. Although the tradition is an improbable tale, it, however, evidently shows that the topographic feature gave such an impression to the local people.

1 T'an, H. C. & Lee, C. Y. Map in "Mineral deposits of Eastern Sikang". Bull. Geol. Surv. China, No. 17, Pl. I.

2 Deprat, J. et Mansuy, H. Etude Geologique du Yunnan Oriental. Pt. I, p. 258.

3 Loczy, L. v. Wissenschaftliche Ergebnisse der Reise des Grafen Bela Szechenyi in Ostasien. Bd. II, pp. 745-746. and atlas sheet Nos. B V, B VI.

4 Gregory, J. W. & Gregory, C. J. To the Alps of Chinese Tibet. pp. 312-313.

From Chinchiangyi (金江驛), the south-most bend of Chinshachiang, leading to Yüanmu (元謀) and Ch'uhsiung (楚雄) of North Yunnan there is the valley of Lungchuanho (龍川河) which is wide and gentle. As the water current of the said stream is rather small and the course of it is not very long, it seems impossible that the Lungchuanho can construct such a valley. Moreover the water-shed between the Lungchuanho and the tributary of Red River is only 800-900 m. above the river level of Chinshachiang and less than 2,000 m. above the sea. Thus Dr. V. K. Ting[1] considers that Yalungchiang, Lungchuanho and Red River were formerly a single valley and became separate after the Yalungchiang was captured by the Yangtze in later time.

The valley of Changchiuho (掌鳩河) in Northern Yunnan which flows to south (fig. 1), lies at an altitude of 2,000 to 2,300 m. and the lakes in Central Yunnan are also nearly at the same level as that of Erhai (洱海) in Talifu. It seems that the Changchiuho was formerly the main stream in this region and flowed southward passing through the lakes. This can also be shown by the fact that the general feature is higher on the north and only a deep valley is cut by Putuho in order to enable the latter to reach the Yangtze.[1] On the north of Yangtze the Tatuho and Anningho (安寧河) in Western Szechuan both sculpture their valleys in gneiss rocks limited by two faults (fig. 1, 3) on both sides, west and east. A tributary of Pulungho (普隆河) on the east of Hueili (會理) named Hungchuanho (鴻川河) is a short stream with a small current of water, but its valley is wide and deep. It separates from Anningho on the north by a 2,000 m. watershed. By this facts Dr. Ting[3] thinks that Anningho has formerly flowed through Hungchuanho to south instead of turning westward to Yalungchiang as the present drainage is. Nearly in the same line the Changchiuho is situated. The watershed between Tatuho and Anningho is 2,600 m. and that between Yangtze and Changchiuho is 2,380 above the sea. Whether the Tatuho and Anningho have been the head valley

1 Ting, V. K. Notes of a Geological traveller, Independent Review, No. 48. pp. 11-12 (獨立評論. 漫遊散記).

2 Depart, J. et Mansuy, H. op. cit. pl. I, Carte Hypsometrique du Yunnan Oriental; Brown, Coggin. Geology of Yunnanfu area, Rec. Geol. Surv. India Vol. 41 Pt. 2, p. 89.

3 Ting, V. K., op. cit. No. 52. pp. 16-17.

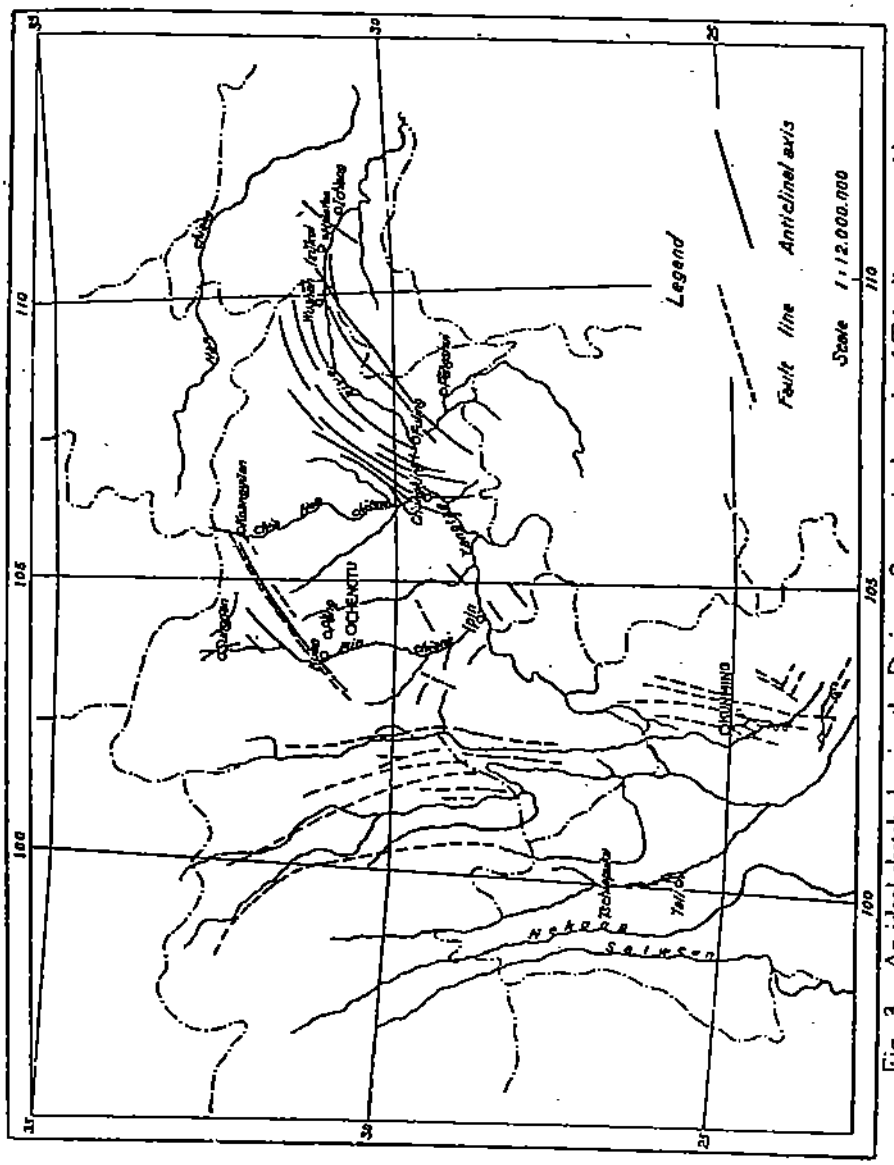


Fig. 3. An ideal sketch showing the Drainage System in the cycle of Tsingling stage with the relation to the principal structural features.

of Central Yunnan drainage, can not yet be decided from the present knowledge although it appears likely (fig. 3).

From the above we may conclude with great probability that the lakes in Yunnan were formed chiefly due to the erosion of ancient valleys in the cycle of Tsingling stage. Although they might be originally affected by faults as Deprat[1] thought, but as the lakes in N. W. Yunnan not entirely coincide with the structural features[2] it is difficult to say that the faults are the chief cause of their formations. The younger Tertiary deposits around the lakes were probably formed at the end of Tsingling stage.

### (3) Yangtze Stage.

The rapid uplifting of the landsurface of upper Yangtze in Early Pleistocene or Plio-Pleistocene time caused the downward cutting of the river to form canyon-like gorges above Ichang as well as in some of its main tributaries. The name Yangtze stage was first applied to this stage by Willis.[3] From the correlation by Willis himself this stage is equivalent to the Fenho stage of North China.

Owing to the rapid headward cutting of the old Yangtze, on the other side, the water of Chinshachiang and Yalungchiang was then captured to east by the uniting of their watersheds. Because of the lesser amount of water in the old Chinshachiang valley south of Tschinpuku it therefore still remains unchanged at a high level inclining to south. The valley of Putuho gradually progressed headward until the south flowing Changchiuho and the lake of Kunyang were captured to the Yangtze as they are in the present time. Most of the tributaries of Yangtze were formed in this cycle (fig. 1).

Deprat[4] correlated his Chinshachiang stage with the Fenho stage of Willis, that is, in other word with the Yangtze stage of S. China. But the downward cutting of the Chinshachiang stage, as he says, up to a depth of more than 2,000 m. seems to be rather exaggerated. If this is true then no where

1 Deprat, op. cit. Pt. II, p. 350.

2 Loczy, L. v. op, cit.

3 Willis, op. cit. pp. 337-338.

4 Deprat, op. cit.

in E. Yunnan except some high picks would be higher than the old river level. Moreover the water-shed at Tschinpuku is only 600 m. above the present river. Most probably the Yangtze stage began with the second or third cycle of Deprat's Chinshachiang stage. And the first one or two cycles of the latter can be included in the Tsingling stage of Willis. In S. W. Hupeh the Sanhsia or gorge stage of Messrs. Hsieh and Liu[1] is apparently the same as of Yangtze, but no peneplanation equivalent to the stage of Ohsi has been seen especially in Szechuan province.

A remarkable stability or down-warping occurred in the middle of the Yangtze stage in which the wide spread gravels were deposited in most of the valleys and some localities in Szechuan basin. The uniform heights of hillocks in E. Szechuan which Heim[2] named it the peneplane was probably formed at this time, because gravels have been found at the top of Chungking hills. In the Wind Box gorge or Chutanghsia (瞿塘峽) the substage of stability or down-warping seems to be represented by the second step of the gorge walls. Possibly the deposit of the Yaotze conglomerate at Sintan was due to this down-warping. We named the gravel in Western Szechuan the Yaan (雅安) formation and the period of its deposition the Yaan stage.

Afterward the uplift movement continued up to the present time and the rivers cut their valleys to the present level.

If the correlation of Yangtze stage with the Fenho stage is correct then we can say that the down-warping or the Yaan stage is apparently equivalent to the Sanmen stage and the later uplift to the Chingshui stage as correlated with the physiography of N. China.[4]

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1 Hsieh, C. Y. & Liu, C. C. Geology of S. W. Hupeh. Bull. Geol. Surv. China, No. 9, pp. 30-32.

2 Heim, A. Studies on tectonics and petoleum in the Yangtze Region of Tshungking, sp. Pub. Geol. Surv. Kwantung and Kwangsi. No. VIII, p. 32.

3 Pumpelly regarded this conglomerate as of Terrace gravel in his "Geological Researches in China, Mongolia and Japan" p. 8.

4 Barbour, G. B. The Geology of the Kalgan Area. Mem. Geol. Surv. China. Ser. A. No. 6, pp. 148 a, b.