

山東中生代及第三紀初期地層分佈圖

MAP SHOWING THE DISTRIBUTION OF MESOZOIC AND EARLY TERTIARY SEDIMENTS IN SHANTUNG

— 之分屬八十百三尺縮
Scale 1:3,180,000



中生代及第三紀初期地層分佈區域
DISTRIBUTION AREAS OF MESOZOIC
AND EARLY TERTIARY SEDIMENTS
化石產地
FOSSIL LOCALITIES

- | | | | |
|----------------|----|----------------|-----|
| 1. AN-CH'U | 安邱 | 18. LIN-CH'U | 臨沭 |
| 2. CHANG-CH'U | 章邱 | 19. LIN-YI | 梁陰 |
| 3. CHANG-LO | 昌樂 | 20. MENG-YIN | 蒙陰 |
| 4. CHIAO-HSIEN | 膠縣 | 21. NING-YANG | 寧陽 |
| 5. CH'I-HSIA | 棲霞 | 22. PENG-LAI | 蓬萊 |
| 6. CHI-MO | 即墨 | 23. PING-TU | 平度 |
| 7. CHI-NING | 濟寧 | 24. PO-SHAN | 博山 |
| 8. CHU-CH'ENG | 諸城 | 25. SSU-SHUI | 泗水 |
| 9. CH'U-FU | 曲阜 | 26. TAI-AN | 泰安 |
| 10. CHU-HSIEN | 巨野 | 27. TSINGTAO | 青島 |
| 11. FANG-TZU | 坊子 | 28. TSINAN | 濟南 |
| 12. FEL-HSIEN | 費縣 | 29. TZU-CH'UAN | 濰縣 |
| 13. HAI-YANG | 海陽 | 30. WEI-HSIEN | 威海衛 |
| 14. HSIEN-T'AI | 新泰 | 31. YEH-HSIEN | 掖縣 |
| 15. KAO-MI | 高密 | 32. YI-HSIEN | 沂水 |
| 16. LAI-WU | 萊蕪 | 33. YI-SHUI | 沂水 |
| 17. LAI-YANG | 萊陽 | 34. YI-TU | 益都 |

COLUMNAR SECTIONS SHOWING

THE SUPERPOSITION AND RELATIVE THICKNESS OF MESOZOIC AND EARLY TERTIARY FORMATIONS IN DIFFERENT REGIONS

OF SHANTUNG

Approximate Scale 1:25,000

一 之 分 千 五 萬 二 約 尺 縮 縮

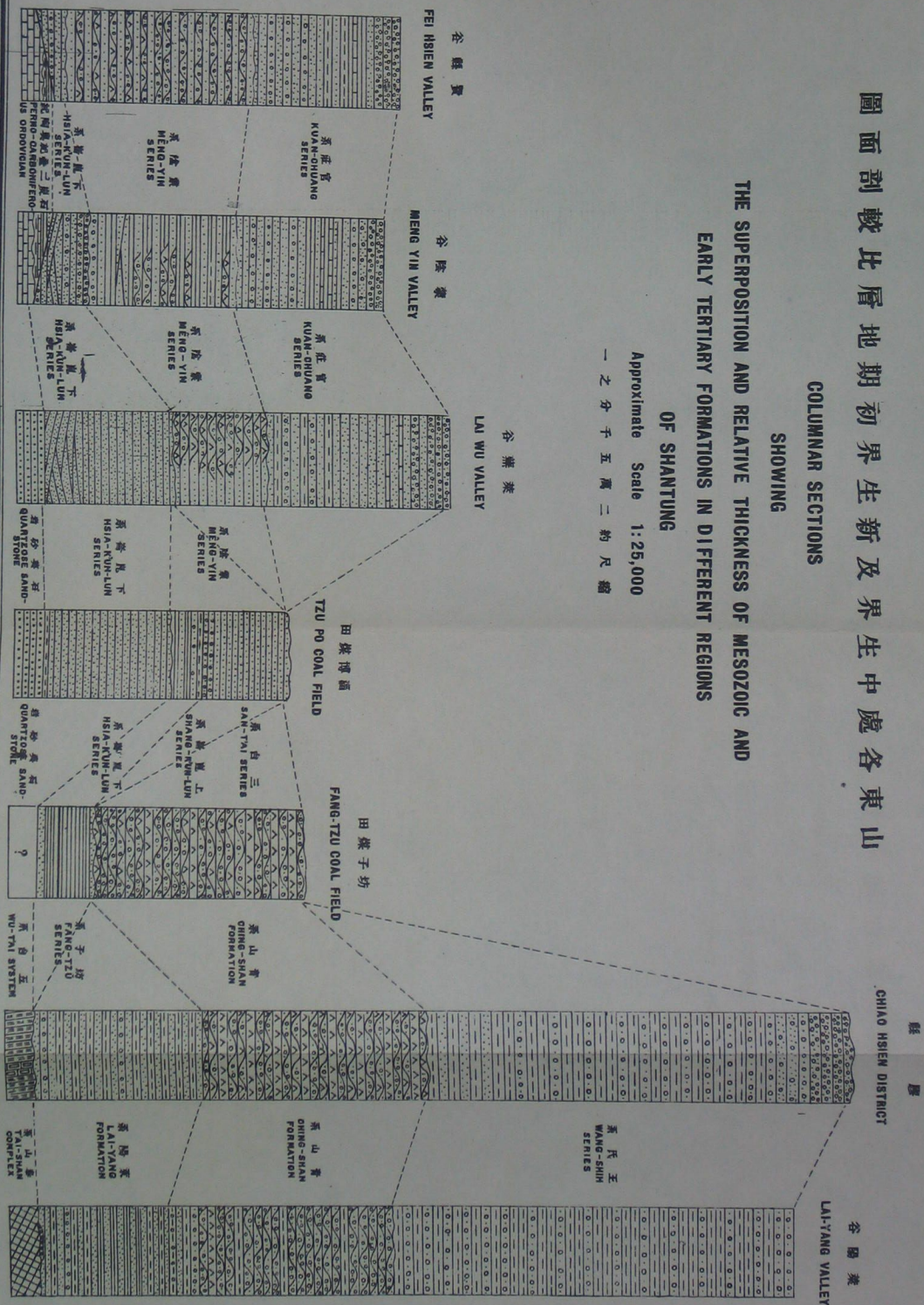
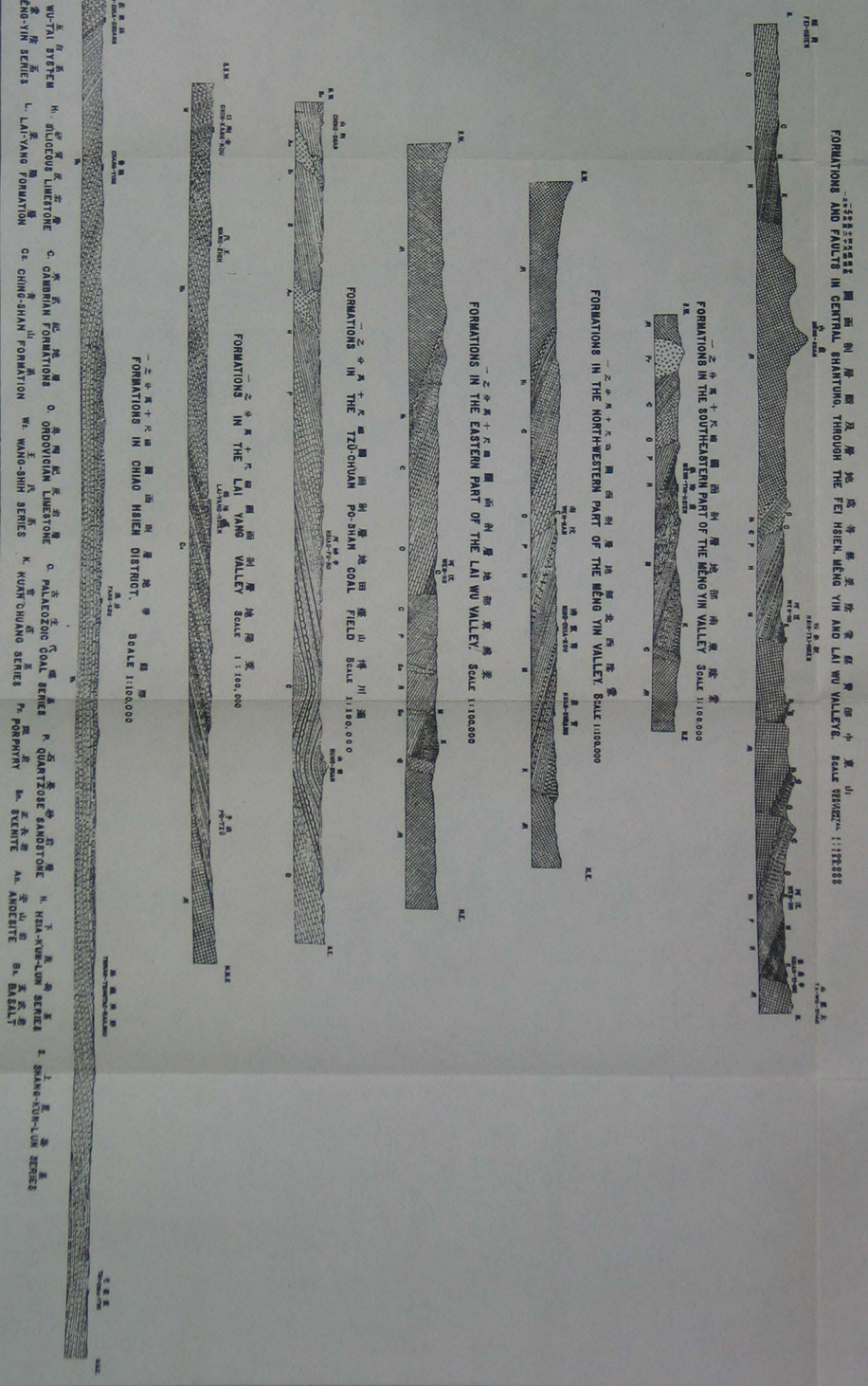
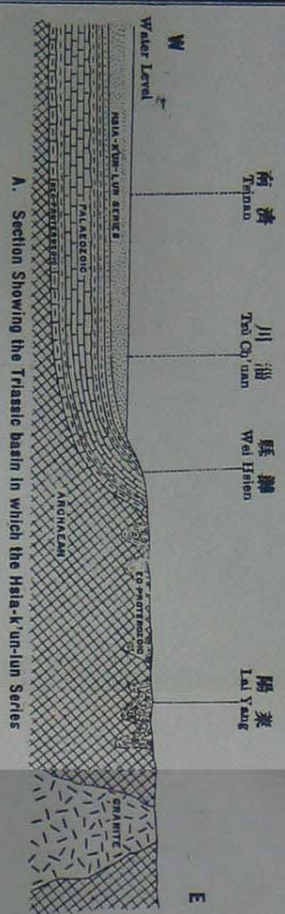


圖 面 剖 層 地 期 前 紀 三 第 及 代 生 中 東 山 SECTIONS SHOWING THE MESOZOIC AND EARLY TERTIARY FORMATIONS IN SHANTUNG



IDEAL SECTIONS SHOWING THE MIGRATION OF THE BASINS
OF DEPOSITION IN DIFFERENT PERIODS.

圖 像 想 布 分 地 盆 積 沉 代 時 各 東 山



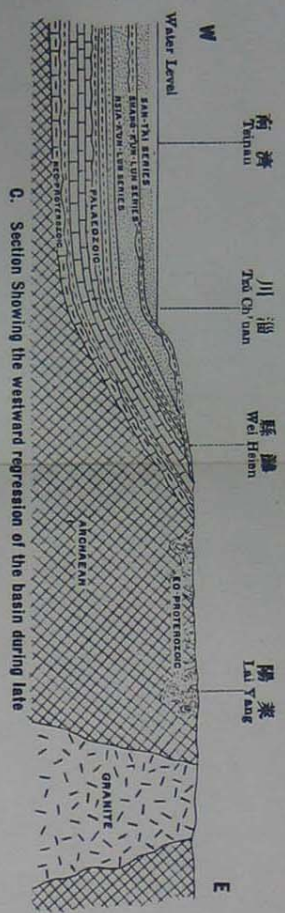
A. Section Showing the Triassic basin in which the Hsia-k'un-lun Series was deposited.

三疊紀之滄海盆地



B. Section Showing the early Jurassic basin in which the Fang-tzu and Shang-k'un-lun series were formed.

滄海盆地之早期三疊紀



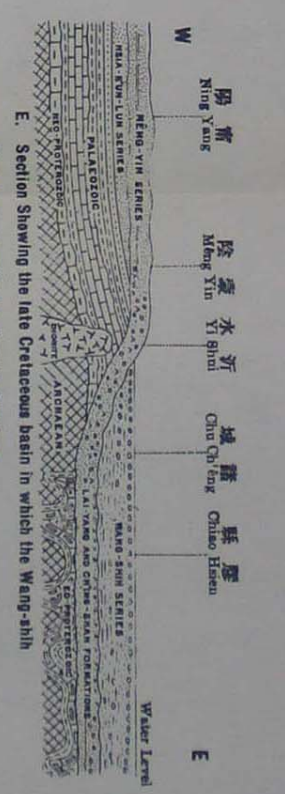
C. Section Showing the westward regression of the basin during late Jurassic time; and in the basin the Santai Series accumulated.

三疊紀末之滄海盆地



D. Section Showing the early Cretaceous basin in which the Meng-yin Series and the Lai-yang and Ch'ing-shan formations were deposited and the overlap of the Ch'ing-shan formation on pre-Mesozoic formations.

滄海盆地之早期白堊紀



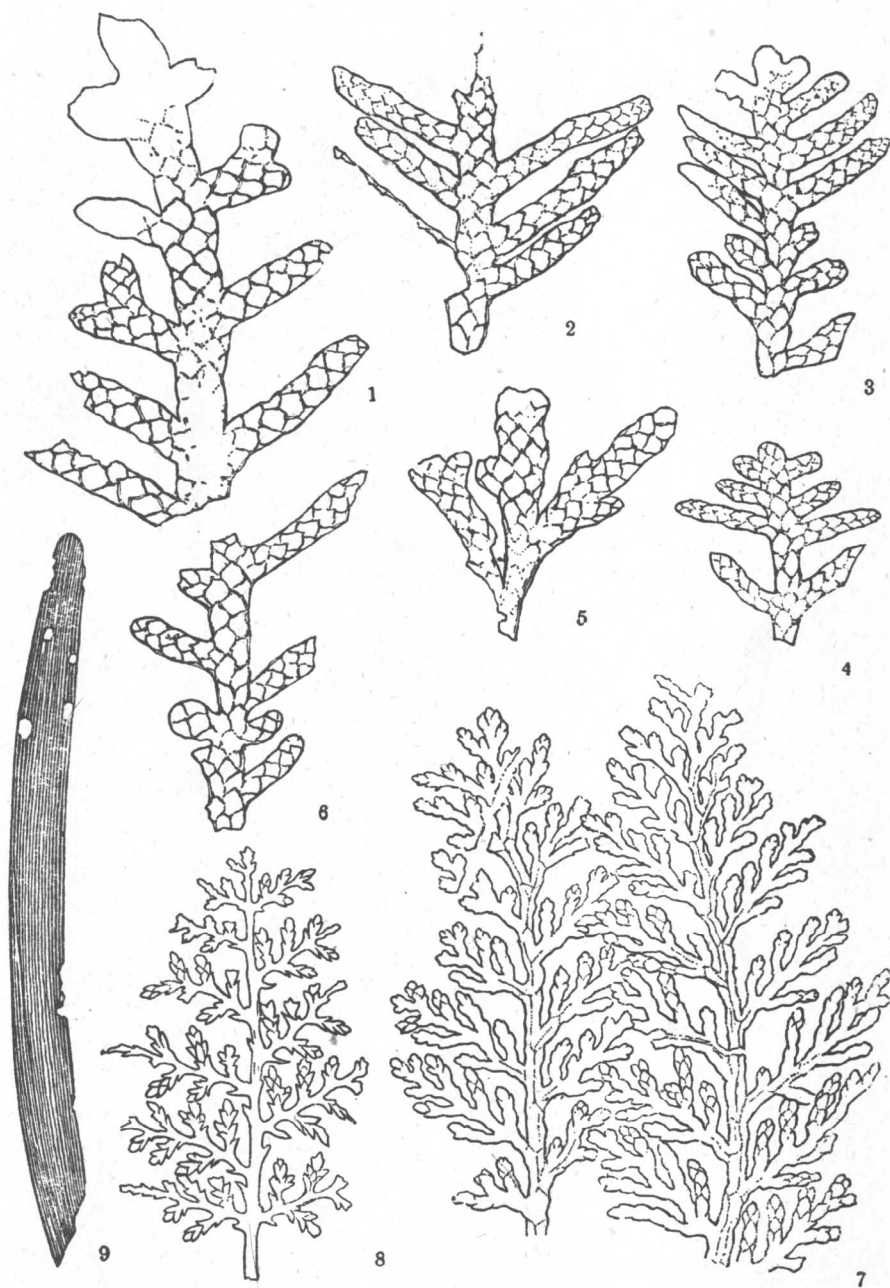
E. Section Showing the late Cretaceous basin in which the Wang-shih Series was deposited in Eastern Shantung.

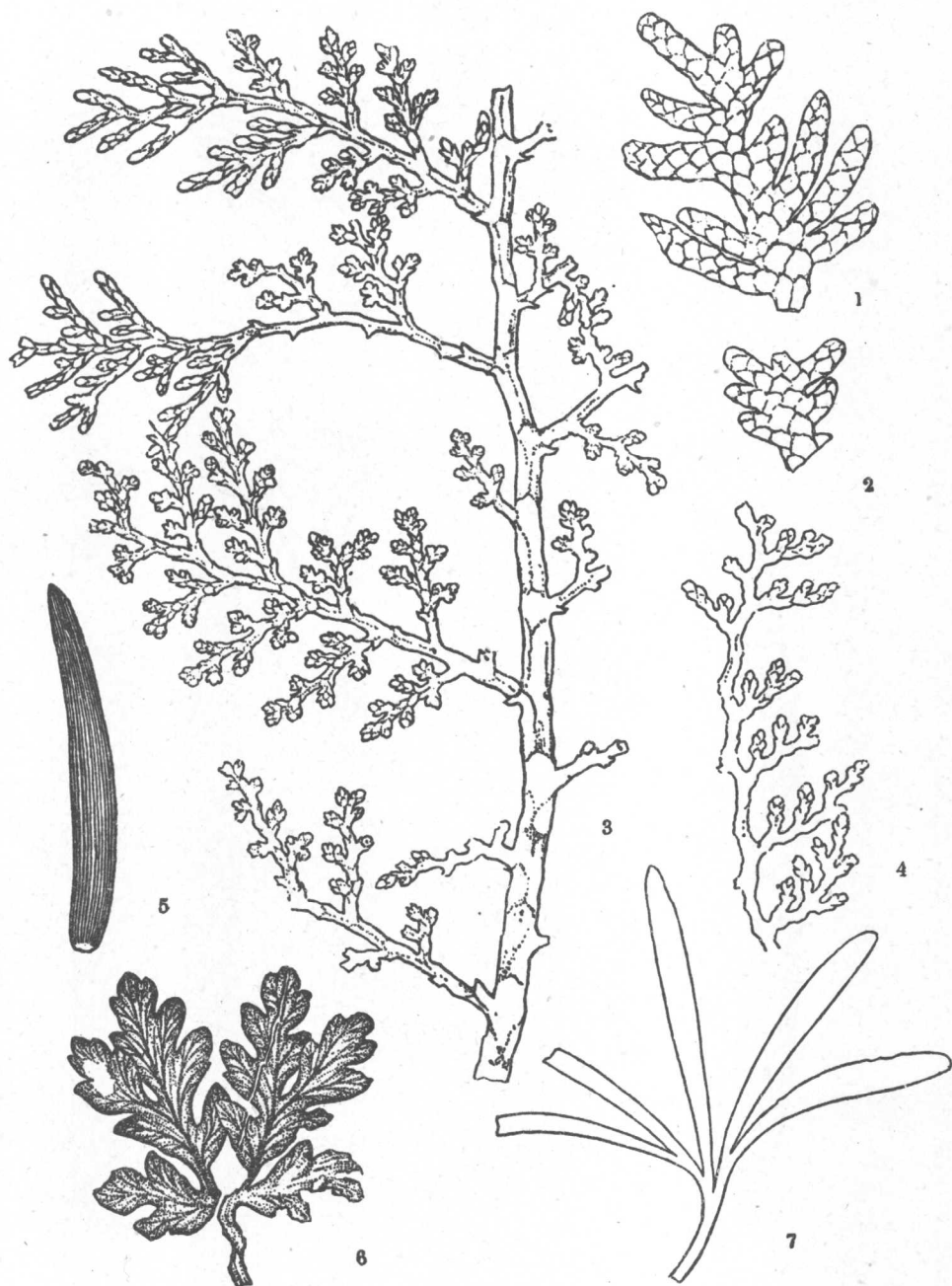
白堊紀末之滄海盆地

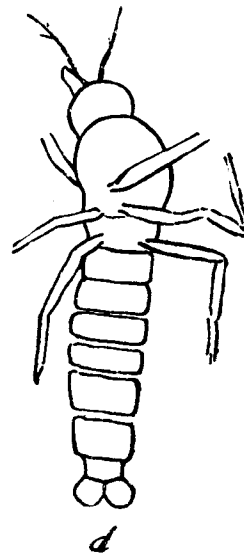
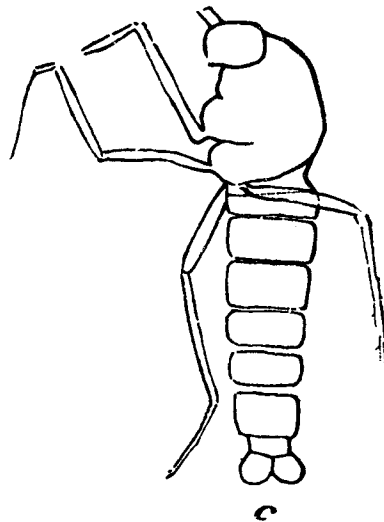


F. Section Showing the early Tertiary basin in which the Kuan-chuang Series accumulated in Western Shantung.

滄海盆地之早期第三紀

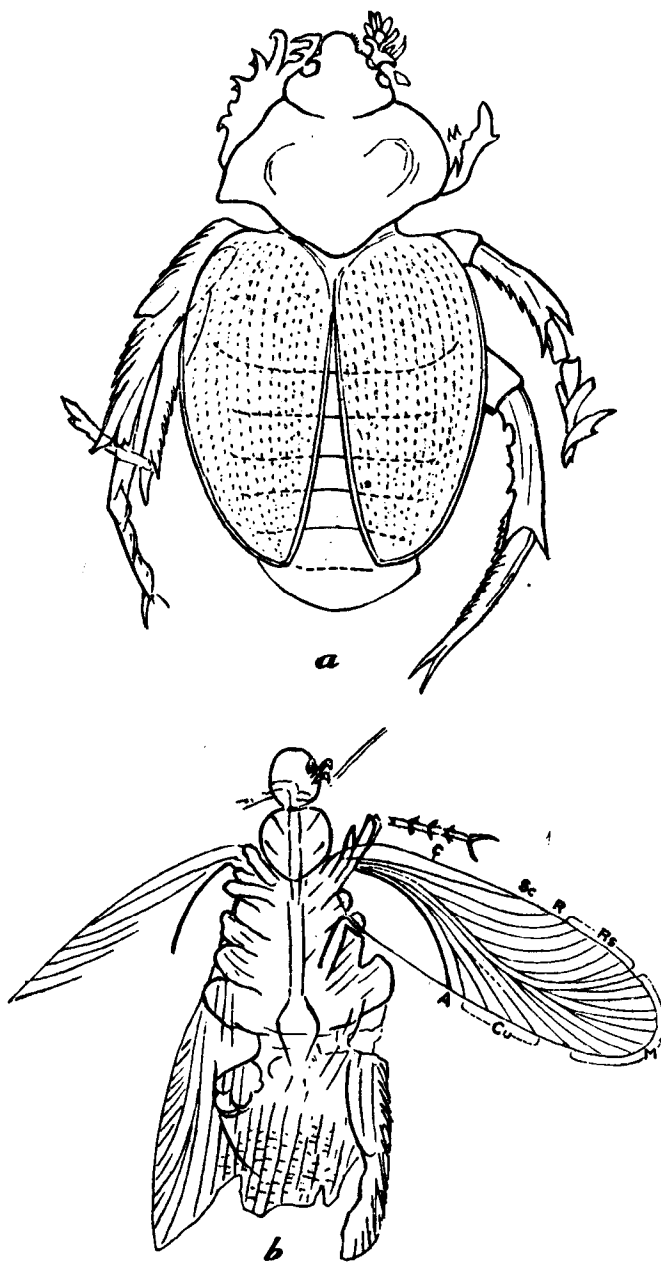






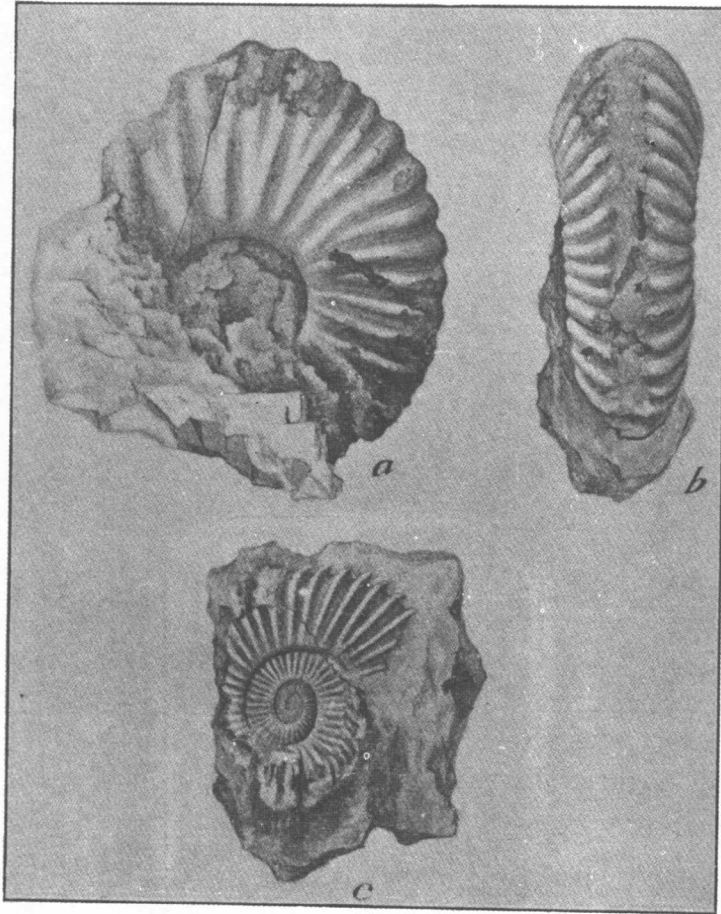
Lower Cretaceous Insects.

a Sinoblatta laiyangensis Grabau (enlarged 3 times); *b-d Samarura gregaria* Grabau, three larvae in different attitudes (enlarged $8\frac{1}{2}$ times). Laiyang Formation, Lai-Yang-Hsien, Shantung.



Lower Cretaceous Insects.

- a. *Proteroscaphaeus yeni* Grabau (enlarged 4 times).
 - b. *Laiyangia paradoxiformis* Grabau (enlarged 4 times).
- Laiyang Formation, Lai-Yang-Hsien, Shantung.



A Lower Cretaceous Ammonite from Hongkong.
Hoplites (Blanfordia) wollichi (Gray) var. *hongkongensis* Grabau,
a, Side view of the largest fragment obtained, natural size;
b, Ventral view of the same specimen, natural size;
c, Gutta percha cast of the inner whorls, taken from impression in
rock, natural size.

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PEKING
THE GEOLOGICAL SURVEY OF CHINA
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NEW RESEARCH ON THE MESOZOIC AND EARLY TERTIARY GEOLOGY IN SHANTUNG

BY

H. C. T'AN.

INTRODUCTION

The geology of Shantung has been surveyed and studied by several well-known geologists, v. Richthofen, Th. Lorenz, B. Willis etc. and appears comparatively clear. But the post-Palaeozoic formations have not been thoroughly studied. The age of most of these formations remained unsettled and the demarkation lines between them remained mostly obscure. B. Willis distinguished the Sint'ai series and the Wenhö conglomerate among the post-Palaeozoic strata, in the Mêng Yin valley. Dr. F. Solgar has left in the Geological Survey a geological map of the Tzŭ-Ch'uan and Po-Shan coal field⁽¹⁾ in which he distinguished among the Post-Palaeozoic sediments Hsiak'unlun formation, Shangk'unlun formation and Sant'ai formation. No definite age however was assigned to these formations. Since the last few years, instead of confining himself to the purely technical work, Dr. J. G. Andersson devoted his attention to the research on the Cenozoic deposits of China which have long been neglected by earlier geologists. He conducted under the auspices of the Geological Survey a systematic campaign of fossil collections, especially reptiles and mammals. Preliminary reports have recently been published under the title of "Essays on the Cenozoic of North China".⁽²⁾

Some six years ago a German mining engineer W. Behagel presented to Dr. V. K. Ting a big sandstone block containing three vertebrae of a fairly large-sized Dinosaur. He states that the specimen originated from the Mêng Yin district in Shantung. It has long been kept in Dr. Ting's mind to locate the point where this remarkable specimen was found, and finally, in 1917, the writer acting upon his instruction, undertook a systematic search for it in the Mêng Yin district. But the search was in vain, though

(1) This field has been resurveyed both topographically and geologically by the author of this paper and a report with the map has been published in Bull. N° 4.

(2) Mem. Geol. Surv. China N° 3.

much time was spent in tracing the Dinosaur bearing formation, and in making inquiries among the natives after the so-called dragon-bone producing localities. In the summer of 1922, when we rearranged our museum the specimen referred to, again came up for consideration; and Dr. Andersson decided to take a trip to Shantung for the purpose of locating the place in which that specimen was found.

There was also another reason for a journey in Shantung. In 1921 Dr. Andersson surveyed the Eocene area of the Yüan Ch'ü district in S. Shansi. The survey of the Yüan Ch'ü area proved the existence of a series of Eocene beds preserved in a sunken block limited by faults with downthrow of something like ten thousand feet. On his return from Shansi Dr. Andersson approached the writer, asking him whether there is any possibility of finding in Shantung young sediments of the type of the Yüan Ch'ü Eocene. The writer then pointed out the existence within several areas of Shantung of several young formations which he has surveyed in the preparation of the Shantung geological map, but the age remained unsettled because of the apparent lack of fossils.

These were the reasons for Dr. Andersson's and the writer's joint journey in Shantung from November 28 to December 21, 1922, a trip which, in spite of its short duration seemed to have thrown much light not only upon the younger formations in question including the Dinosaur bed, but also upon the tectonic development of the area. In addition to the Dinosaurs, fishes, turtles and mussels, found in the Mesozoic beds, we also obtained Mammals and Gastropods from the Eocene beds.

This was the first time that animal fossils of continental Mesozoic deposits were found in China proper.⁽¹⁾

The area surveyed in the mentioned trip was limited to the Mêng Yin and Lai Wu valleys. On returning from Shantung Dr. Andersson proposed that further research should be made in other parts of that province. So in the spring of the present year Dr. O. Zdansky went to central Shantung, especially to the Lai Wu, Mêng Yin and Fei Hsien valleys to

(1) A preliminary report has been communicated to the Geological Society of China see Bull. Geol. Soc. China Vol II pp. 29- 3.

undertake more collecting work, and the writer went to Eastern Shantung, especially to the Lai Yang, Chiao Hsien and Chu Ch'eng districts, for the purpose of finding the fossiliferous beds in the young formations. Success at last crowned both efforts and several new faunas were discovered.

On returning from Shantung Dr. Andersson decided to write a joint paper with the writer on the results of the above mentioned trips to be printed in the Bulletin of the Geological Survey. As, however, his time was so fully occupied with preparation for his Kansu journey, he did not find the opportunity to complete the paper and left that task to Dr. Zdansky and the writer, who were thus enabled to insert in the paper the results of their new researches made during the latest trip.

A short time after his return to Peking Dr. Zdansky undertook the study of the cave deposits at Chou K'ou Tien where he was obliged to remain for several weeks occupied with excavation work. Thus Dr. W. H. Wong entrusted to the writer alone the preparation of this paper which is intended to record the field observations for which the writer is mainly responsible.

Moreover, it is also Dr. Wong's suggestion that all the observations on the post-Palaeozoic formations in Shantung, which were made by the writer on previous occasions should be brought together here, so that this paper might become of use in correlating all the post-Palaeozoic formations of Shantung.

As, however, some formations have not yielded any fossils, the writer is compelled in such cases to base the correlation solely upon stratigraphic relation or lithic characters.

A general account of all the post-Palaeozoic formations in Shantung may, however, be given and their mutual relations discussed, and so, in accordance with Dr. Wong's suggestion, the writer proposes to extend this paper so as to include the Mesozoic and Eocene formations which occur in other parts of Shantung, as well as those in the Mêng Yin, Lai Wu, Fei Hsien and Lai Yang valleys and in the Chiao Hsien and Chu Ch'eng districts.

It gives the writer great pleasure to express his thanks to the many gentlemen who have assisted him in this undertaking. To Dr. Andersson he is under particular obligations for his experienced guidance in the fossil collections, his kindness of entrusting to the writer the preparation of this paper and much help also in the interpretation of the structural facts. Dr. Zdansky has kindly furnished him the valuable palaeontological data concerning the vertebrate fossils, and Dr. Grabau has undertaken the study of invertebrate fossils and has by his enthusiasm for scientific research very much encouraged the author to write this paper. Mr. Chow kindly undertook the description of the plant fossils.

TOPOGRAPHY.

The areas here in question almost entirely occupy comparative lowlands, either in the valleys and basins or on the margins of the mountainous regions. For in Shantung most of the lowlands are composed of the young formations which will be described below (see Plate I).

The regions which were touched in the later trips are in the Mêng Yin, Lai Wu, Lai Yang, and Fei Hsien valleys and in the Chiao Hsien and the Chu Ch'êng districts. The other places where the post-Palaeozoic formations occur were visited in previous journeys.

In western Shantung the lowlands that are composed of the post-Palaeozoic formations are mostly separated by the mountain ranges which are chiefly made of the Archean gneiss, whereas in eastern Shantung the lowlands of the young formations are generally surrounded by the mountain ranges of the Archean and Palaeozoic formations, though in some places the mountains project from them. In the Yi Hsien, Tzŭ Ch'uan, Po Shan and Chang Ch'iu coal fields as well as in the Mêng Yin, Lai Wu and Fei Hsien valleys there occur the post-Palaeozoic formations. Between the Yi Hsien basin and the Fei Hsien valley lies a mountainous region which contains different sets of elongated mountain ranges and isolated hills which all consist of pre-Mesozoic formations. The mountains are not very high, the highest peak among them attains an elevation of not more than 700 meters. Between the Fei Hsien valley and Mêng Yin valley there lies an extended mountain range called the Mêng Shan Range, the summit of which rises to more than

1000 meters above sea level. The Mêng Yin and the Lai Wu valleys are separated by the Hsin Fu Shan Range, the highest peak of which is more than 900 meters above sea level. The Tai Shan Range which is famous by the height of its main peak at about 1500 m. lies between the Lai Wu valley and the Tzŭ Po and Chang Ch'iu coal fields. The Yi Shui valley is separated by mountain ranges from the Mêng Yin valley on the western side and from the Chŭ Hsien valley on the eastern side. The lowlands in Ch'ang Lo, Wei Hsien, An Ch'iu, Chu Ch'êng, Chiao Hsien, P'ing Tu and Chi Mo are all composed of the post-Palaeozoic formations and are surrounded by the Yi Shan Range on the west the Ma Erh Shan Range on the south and the Lao Shan Range on the southeast, Ku Shan Range in P'ing Tu and Ching Shan range in Lai Yang. These lowlands may be called the lowland of Eastern Shantung. The Lai Yang valley is separated from the lowland of Eastern Shantung by the Ching Shan Range. The mountain ranges which separate and surround the lowlands are all made of the pre-Mesozoic formations. The topographical features of the valleys, basins and lowlands which are composed of the younger formations will be separately stated as follows:

The Mêng Yin valley includes the regions through which the tributaries of the rivers Wenho and Yiho with their subsidiary streams pass. The tributary of Wenho also called Wenho has its course in the western part of the valley and the tributary of Yiho called Tung Wenho finds its way in the eastern part. The former flows out from the valley westward and the latter southeastward. In front of the Hsin Fu Shan Range standing on the north of the valley and extending southeastward there are many hills which constitute the northern margin of the valley and are mostly made of the Eocene beds. -Along the northern foot of the Mêng Shan Range there stand also many hills which form the southern margin of the valley and are composed largely of the red sandstone and its underlying formations. In the middle part of the valley lies a low ridge which commences on the north of Wennan and terminates at the northern bank of Tung Wenho, southeast of Mêng Yin city; it is only made of the so called Mêngyin series and exhibits apparently the feature of the typical bad lands. Most of the western part of the valley is covered by the alluvium underneath which the Eocene beds seem

to hide here and there. The valley was formed after the strata had been partly sunken down by the faulting which affected the tectonic features of the whole province. Subsequently the rivers Wenho and Tung Wenho became established and found their way in opposite directions. The valley is in the sub-mature age but is still undergoing peneplanation. Between the two rivers lie only some low hills which form their watershed; when one river will have been captured by another, the hills will be dissected or swept away.

The Lai Wu valley is dissected by another tributary of the Wenho with its subsidiary streams. The main river flows westward, turns to the southwest after leaving the valley and unites at Ta Wen K'ou with the river running from the Meng Yin valley. Along the northern margin of the valley lies a series of hills, these being composed of Archean on the northern slope and of the upper part of the Eocene beds on the southern slope. In the central part of the valley stands a conspicuous hill which is named K'uang Shan and is made of diorite, and in the eastern part there are many flat low hills which consist mostly of post-Carboniferous formations and some igneous bodies. Westward from K'uang Shan the land which comprises mostly the Eocene beds becomes lower and lower; it forms only the flat and elongated hills and becomes a plain on reaching the boundary between Lai Wu and T'ai An districts. Along the northern foot of the Hsin Fu Shan Range there are many hills which form the southern margin of the valley and are composed of the Palaeozoic formations and of diorite intrusion. Most of the land along the streams is covered by alluvium. As it has originated the Meng Yin valley, the faulting also caused the formation of the Lai Wu valley which sunk down as the downthrow-side of the trough faults. The Lai Wu valley as well as the Meng Yin valley, is in a sub-mature stage and is being peneplained. Most of the valley region does not show high relief, though somewhere rocks still retain the conspicuous form owing to their considerable resistance.

The Fei Hsien valley is much longer and broader than the two above stated. The two ends of the valley are both open and immediately connected with the plains without any remarkable divide between them. Only the middle part of the valley was visited by Dr. Zdansky in his later trip, but

most has been covered by the writer's tracks in former journeys. The valley is more than 200 li long and composed of the regions through which the rivers Tzun Ho and Ssü Ho pass. The former with its tributaries runs southeastward and the latter westward, and between them lie some low hills which form their watershed. Along the northern margin of the valley there are flat low hills, most of which comprise the upper part of the Eocene series. The Palæozoic formations compose the southern margin forming the transition between the mountainous region and the valley. The constituents of the eastern part of the valley are both the Mesozoic and Cenozoic formations, but in the western part only the Eocene series predominates and the Mesozoic strata are missing. Most parts of the valley contain flat low lands which appear to be in the latest mature stage and even in more advanced stage in the eastern part. Contemporaneously with the above mentioned valleys the Fei Hsien valley was established as soon as the central part of Shantung was subjected to breaks by the faulting. But it seems to have been undergoing greater peneplanation, so that the stage which it attains at present is more or less older than the Mêng Yin and Lai Wu valleys.

On the northern margin of the T'ai Shan Range are situated the Tzu Po and Chang Ch'iu coal fields, the lowlands of which are partly formed of the post-Palæozoic formations. The younger formations were invaded by many igneous intrusions which form isolated hills rising from the lowlands. A big mountain Ch'ang Shan is of this type, but the igneous body composing this mountain, very much affected the younger formations. The river Hsiao Fu Ho with its tributaries passes through the Tzu Po field and one part of the Chang Ch'iu field. According to the relief these lowlands are being peneplained. The establishment of the lowlands is due partly to warping and partly to faulting.

The Yi Hsien basin is situated at the southwestern end of the mountainous region of Shantung. It contains Palæozoic coal series, quartzose sandstone and red sandstone. The latter is regarded as the early Mesozoic formation and spread only in the northern part of the basin. The formation of the basin is also due to the faulting: