THE COAL FIELD OF MENTOUKOU, WEST OF PEIPING

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Introduction.

The Western Hills of Peking are, since very remote times, well known for coal production and Mentoukou is one of the most productive districts among these hills. On account of its economic importance it was visited by several geologists of the Geological Survey especially by C. C. Liu and L. F. Yih whose results were already published in the Memoir of the Survey under the title of "Geology of Hsi Shan". In may of 1932 the authors at the request of Sino-British Coal Mining Co. made a more detailed survey in the area. They especially paid attention to the distribution of different coal seams and to the tectonic features of the coal field.

Physiographic Features.

The coal field under consideration mainly drained by a branch of the Hunho river occupies a broad valley and is only about 25 km. distant from Peking with which it is connected by a railway called Peking-Mentoukou line.

Near the junction of the Hunho with the Mentoukou valley appears a flat basin about 2 km. in diameter surrounded by moderately high hills except on its south margin where the basin opens into the Peking great plane. From the junction westward up the Mentoukou stream the valley gradually becomes nar-

rower and narrower and will soon be found its head waters near the temple of Fêngkou in a distance only about 8.5 km. from Mentoukou station. In spite of a short valley it has been developed in a complex history if a closer view is made on its erosion features. Generally speaking, there can be distinguished four terraces which are especially distinct in the lower part of the valley on the north side (Fig. 1).

Fig. 1. Ideal section showing the terrace features of the Mentoukou valley.

The lowest level of the valley is represented by the present course of the stream. Between Potou and Kengwangfen its width is about 1 km. and its height above sea level is about 120 m. It is composed mostly of gravels, indicating the sluggish aggregated condition of the stream. The second terrace is well preserved by the flat areas near Lungmen and Kengwangfen where it is about 20-30 m. above the present course and only scarcely dissected by small gullies. This is the most easily recognised terrace and consists mainly of reddish clay and rock talus. The third and fourth terraces are not so notable as the second and all composed of rock formations, but they are readily identified if one climbs up Chiulungshan from the valley. W. of the valley Mentoukou, all the terraces mentioned seem to merge into a single one. If the reddish clay remnant in the second terrace is equivalent to the reddish deposit as stated by Mr. Teilhard[1] in geological age, the formation of the terrace in the Mentokou valley should be pre-Pleistocene. Further from the terrace features it seems that degradation and aggregation conditions were repeated at least three times since the beginning of cutting the Mentoukou valley which should have thus passed a complex history.

1. P. Teilhard & C. C. Young. Preliminary observation on the pre-Loessic & post-Pontian formations in western Shansi and northern Shensi. Mem. Geol. Surv. China, Ser. A. No. 8. 1930.

Stratigraphical Sequence.

In the Memoirs of "Geology of Hsi Shan" by Mr. Yih the whole coal-bearing formation exposed in the valley of Mentoukou is treated as one unit called Mentoukou coal series. During the authors' trip they soon discovered that nearly all workable coal seams are contained only in the lowest portion of the coal-bearing series. Consequently in facility of tracing the distribution of important coal seams it seems advisible to reclassify Mr. Yih's Mentoukou coal series into the following three subdivisions:

1. *Lower Yaopo Series*: This is the lowest one of the three subdivisions and, being mainly buried under river gravels, it is hardly to be described in detail. Fortunately, on the north of the village Hsihsinfang a bore hole by the former Tunghsin coal mine was made through all workable coal seams. The records of this boring are as follows (from below upwards).

1.	Blue sandy shale			17.	Gray sandstone	9	,,
2.	Black shale	3.7	ft.	18.	Blue shale	6	,,
3.	Blue shale	31.6	,,	19.	Gray sandstone	1	,,
4.	Black shale with coal partings	2	,,	20.	Blue shale	11	,,
5.	Gray sandstone	55.8	,,	21.	Gray to bluish sandstone	37	,,
6.	Blue shale	18.6	,,	22.	Gray to bluish sandy shale	28	,,
7.	Black shale	2.8	,,	23.	Gray sandstone	7	,,
8.	Coal	1	,,	24.	Black shale	70	,,
9.	Black shale	1	,, 2″	25.	Gray sandstone	20	,,
10.	Coal	1	,,	26.	Fossiliferous black shale	12	,,
11.	Black shale	1	,, 4″	27.	Gray sandstone	1	,, 2″
12.	Coal	1	,, 8″	28.	Coal		7″
13.	Black shale	53	,,	29.	Gray sandstone	8	,,
14.	Coal seam (Ching Mei Ta Hsien?)	8	,,	30.	Black to bluish shale	13	,,
15.	Gray sandstone	74	,,	31.	Gray sandstone	7	,,
16.	Coal seam with black shale partings	2	,,	32.	Black to bluish shale	7	,,
				33.	Coal seam (Mining Mei Ta Hsien)	7	,,

34.	Blue to gray sandstone	32	,,	52.	Black to blue shale	7	,,
35.	Blue shale	42	,,	53.	Coal		6″
36.	Gray sandstone	4	ft. 6″	54.	Black shale	1	,,
37.	Black shale	3	,,	55.	Gray sandstone	100	,,
38.	Gray to bluish sandstone	60	,,	56.	Black shale	4	,,
39.	Black shale	6	,,	57.	Coal seam		
40.	Coal	2	,,		(Hei Mei Erh Hsien)	5	,,
41.	Black shale	11	,,	58.	Black shale	2	,,
42.	Coal	2	,,	59.	Coal	2	,,
43.	Black shale	1	,,	60.	Black shale	12	,,
44.	Coal	1	,,	61.	Gray sandstone	150	,,
45.	Blue to black shale	68	,,	62.	Coal seam		
46.	Coal	1	,,		(Tze Erh Tsao)	13	,,
47.	Black shale	9	,,	63.	Blue shale	5	,,
48.	Coal seam (Hei Mei			64.	Coal		6″
	Ta Hsien)	9	,,	65.	Gray sandstone	26	,,
49.	Gray sandstone	85	,,	66.	Black shale	6	,,
50.	Coal		11″	67.	Coal	1	,,
51.	Gray sandstone	60	,,	68.	Gray to black shale	47	,,

In the above section the total thickness from No. 1 to No. 68 is about 1316 ft. or about 440 meters.

Above this section the rock beds are only partly exposed in the gullies in the north low ridges of the valley and they are mainly arkose sandstone. The new shaft of the Sino-British Mine, which is about 1560 ft. on the N. E. of the boring hole, seems to furnish a more detailed succession of this part.

In the shaft the lowest coal seam is stratigraphically about 283 ft. from the workable coal seam Tzuerhtsao which is equivalent to the coal seam No. 62 in the boring section. As the stratigraphic thickness from No. 63 to No. 68 in the boring hole is only about 85 ft., the stratigraphic distance from No. 68 to the lowest coal seam should be 200 ft. unrecorded in the shaft and is provisionally assigned as No. 69 while the lowest coal seam in the shaft is denoted as No. 70.

The rock sequence in the shaft from below upwards is as follows:

70	Coal seam	2′	77	Black shale	4′
71	Black shale	2′ 8″	78	Gray sandstone	6′
72	Coal	1′ 4″	79	Black shale	5′
73	Black shale interbedded with sandstone	30′	80	Gray sandstone	15′
			81	Black shale	31′
74	Coal	1′	82	Gray sandstone	63′
75	Black shale interbedded with sandstone	20′	83	Black shale	9′
			84	Gray sandstone	18′
76	Gray sandstone.	5′	85	Black shale	76′
			86	Dark gray coarse arkose sandstone	

In the above section the total thickness from No. 70 to No. 85 is about 288 ft., while the whole thickness from No. 1 to No. 85 is about 1804 ft. or about 601 meters.

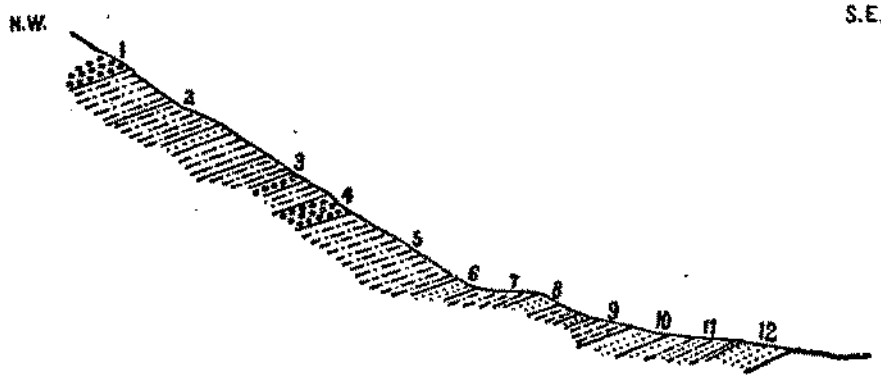

Fig. 2. Geological section along the valley of Yaopo showing the strata of different rock series.

Lungmen Series

1. Basal conglomerate of the Chiulungshan formation.
2. Bluish gray sandy shale with thin layers of sandstone.
3. Black to gray fossiliferous sandy shale, local conglomeratic.
4. Gray conglomerate consisting mostly of quartzite pebbles.

Upper Yaopo Series
5. Gray sandy shale.
6. Gray sandstone.
7. Gray sandy shale.
8. White to dark arkose sandstone.

Lower Yaopo Series
9. Gray shale and sandstone
10. Gray sandstone.
11. Gray sandstone interbedded with thin shales.
12. Gray sandstone.

In the valley of Yaopo the authors have measured a section (Fig. 2) which is shown from the dark gray arkose sandstone or No. 86 in the shaft section downwards as below:—

8 Dark gray arkose sandstone

9 Gray shale and sandstone on the outcrop of which is located a native pit working for the coal seam Heimeichsien equivalent to No. 57 in the boring section, 54 m.

10 Gray sandstone, 12 m.

11 Grey sandstone interbedded with the thin shales, 18 m. Near the bottom of this bed there is a native pit dug for the coal seam Heimeitahsien equivalent to No. 48 in the boring hole.

12 Grey sandstone, 20 m. Near the base of this bed a native pit is said to be working for the coal seam Mingmeitahsien equivalent to No. 14 in the boring hole.

In the above section the difficulty is where the workable coal seams should be interposed. By comparing the section measured with those in the boring hole and in the shaft it is evident that a detailed correlation can hardly be made. The reason may be either due to incorrect measurements of different sections or due to rapid variation of thickness of strata in different localities or both.

Though the Lower Yaopo Series is mostly covered by Cenozoic detritus in the lower course of the Mentoukou valley, it is partly exposed in the upper valley and especially on the southern slope of the valley where it is distinct in contact with diabase and seems having suffered a little metamorphism from the intrusion, the coal being partly altered into graphite and known as Chingmei.

The diabase intrusion constitutes the main part of the southern hill of the valley and part of the Lower Yaopo Series is cut away by the igneous body. Hence, the relation of the Lower Yaopo Series with its still lower sedimentary formation is not exhibited in the Mentoukou area.

2. *Upper Yaopo Series*: This is directly succeeding the Lower Yaopo Series. Geologically it seems not necessary to be separated as one individual series, but economically such a separation is in great significance in order that the workable coal seams may be much more restricted in a rock series and more easily traceable for mining prospecting.

The lowest member of the Upper Yaopo Series is a dark gray coarse arkose sandstone which usually appears in isolated rounding bodies due to unequal weathering along its different joint planes. Under microscope, it is composed mainly of plagioclase feldspar and quartz, and both are in angular fragments, and much altered into sericite. The feldsparthic sandstone is, however, not the only bed occurring in the formerly called Mentoukou coal series, but it seems to be the uppermost feldspar bearing horizon and thence downwards many similar arkose sandstones exist in the Lower Yaopo Series and also give the same appearance on weathering. On account of this, the recognition of Upper Yaopo Series from Lower Yaopo sediments may in places be difficult, even though they are not wholly indiscriminate.

The succession of the Upper Yaopo Series as measured in the valley of Yaopo (Fig. 2) is, in ascending order, as below:

8.	White to dark grey arkose sandstone	13 m.
7.	Gray sandy shale	18 m.
6.	Gray sandstone	10 m.
5.	Gray sandy shale	67 m.
4.	Gray conglomerate	

From No. 8 to No. 5 the total thickness is about 108 m. Undoubtedly there are some thin coal seams among the above strata.

The predominantly shaly matter through the whole series is characteristic as compared with the Lower Yaopo Series which is mainly sandy.

The series is well exposed along the north side of the valley from Kengwangfeng westward through Lungmen and Shihhsiang to the north of Yaopo.

3. *Lungmen Series*: This rests conformably on the Upper Yaopo Series though a disconformity between them may also be possible. At the contact the Lungmen Series is represented by a conglomerate consisting mostly of quartzite pebbles and intercalated with gray sandstone. The pebbles are all well waterworn and generally 1-5 inches in diameter. Before the deposition of the conglomerate whether there is a physically eroded surface or not is not clear in the field, but so far as we know, the conglomerate is the only horizon in the formerly called Mentoukou coal series. The separation of the Lungmen Series from its lower two subdivisions is, thus, without difficulty in the field. The general sequence of the whole series as measured in the Yaopo valley (Fig. 2), is shown below in ascending order.

4. Gray conglomerate mostly of quartzite pebbles besides a few igneous fragments. 10 m.

3. Black to gray fossiliferous sandy shale, local conglomeratic. 45 m.

2. Bluish gray sandy shale with some thin layers of sandstone and a thin seam of coal. 104 m.

1. Conglomerate.

From 4 to 2 the total thickness is about 160 m.

The Lungmen Series distinctly crops out along the southern slope of Chiulungshan and is easily traceable, it being marked both above and below by two conglomerate beds.

The total thicknesses of the above mentioned three subdivisions amounts to 868 m. which is much thicker than the figure (700 m) estimated by Mr. Yih.

As to the geologic age all the three subdivisions are provisionally assigned to Lower Jurassic before detailed determinations of the authors' collections from the three divisions are made. Above the Lungmen Series comes the so-called Chiulungshan formation of barren strata composed chiefly of green sandstone and green or violet shales and usually forming high hills. The

authors only studied the formation along the Menchai railway cutting north of the Mentoukou Station as shown in Fig. 3. At the contact of the Chiulungshan formation with the Lungmen Series there is a basal conglomerate composed mainly of quartzite pebbles though igneous material is also present. This conglomerate is much like that in Lungmen Series and probably indicates a disconformable gap between the Chiulungshan and Lungmen Series.

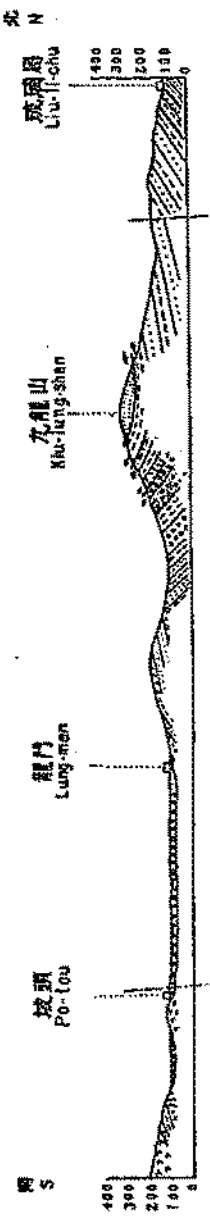

Fig. 3. A generalized geological section from Potou to Liukouchu along the Hunho river.

Geologic Structures

As shown in the memoir of "Geology of Hsi Shan", the coal-bearing formation along the Mentoukou valley just constitutes the southern limb of the Chiulungshan syncline, but there are some other detailed structures not mentioned before. The most important is the anticline (Fig. 4) on the west of the station of Menchai Railway. Its axis trending in a E-W direction more or less parallel to that of the Chiulungshan syncline and extended in a length of 1000 m. more, is composed chiefly of Lower and Upper Yaopo Series, while its southern limb consists of Upper Yaopo Series and its northern limb of Upper and Lower Yaopo as well as Chiulungshan formations.

Besides folding, there are some dislocations worthy of paying attention. One is located on the southwest of Shihhsiang where the gently dipping dark arkose sandstone suddenly bends at high angles against the fault plane. The upthrow side on the southwest of the fault line often reveals distinct shearing surface. The length of the fault so far as traced in the field is about 600 m.

In the upper course of the Yaopo valley the conglomerate of the Lungmen Series appears

repeated in different surface levels, probably indicating the existence of another fault though it may be just a continuation of the fault mentioned.

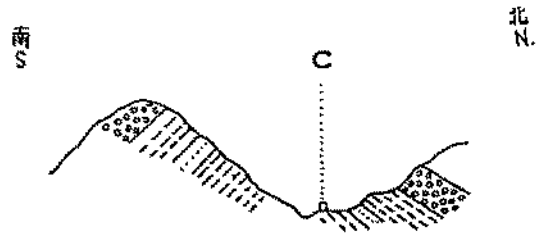

Fig. 4. An anticlinal structure at Choutzechi's tomb c. W. of the Menchai Railway Station.

From Shihsiang to Lungmen there is a E-W fault as met with by the underground miners during mining operation, which gives serious troubles to the Sino-British Coal Mining Co. On the surface outcrops the fault is only shown by incongruous contact of dark arkose sandstone with the grey sandy shale of Upper Yaopo Series. Its downthrow side is on the north and its vertical displacement as estimated from the rock contact along the fault line seems not more than 60 m. Its recognised length is about 1000 m.

Fig. 5. A fault plane exposed on the south of Mentoukou.

On the south side of the Mentoukou valley there also occurs a notable fault running from E by N to W by S in a distance of about 4000 m. The dislocated feature is well shown in Fig. 5 with upthrow side on the south. It is not traceable on the east of Tunghsinfang, being covered beneath river gravels, but it is distinctly shown by slicken sides on the diabase at Pashihmuti.

The Chiulungshan formation exposed on the east of the Hunho river near Sanchiatien seems to be discontinuous with that on the west of the river. This phenomenon may be well explained by a dislocation now just followed by the course of the Hunho at Sanchiatien.

All the dislocations mentioned above, probably belong to normal faults; in fact there are some other types of fault as will be described below.

On the north of Shihhsiang (Fig. 6) the upper most horizons of the Upper Yaopo Series dip towards S. W. at an angle of 75° while the conglomerate of the Lungmen Series directly overlying them inclines to N. W. at a much

Fig. 6. An overthrust and a normal fault occurring on the northwest of the Sino-British Coal Mining Co.

gentler angle of 25°. This may be interpreted as an overthrust with Lungmen Conglomerate put on the Upper Yaopo Series, the former being conformable with the latter in all other places. Just northeast of the thrust there occurs a normal fault trending northwest to southeast.

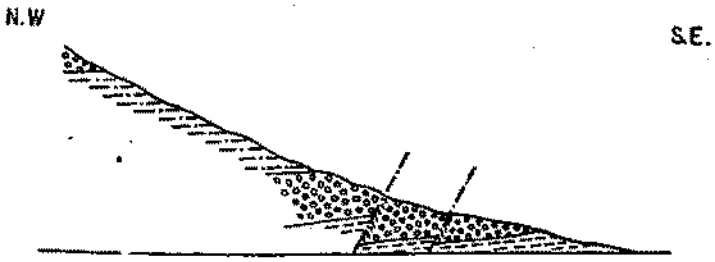

Fig. 7. Two reversed faults in the basal conglomerate of Lungmen Series, N. W. of Lungmen, showing distinct slicken sides and gash joints.

Further, there still are some reversed faults of small throw occurring in the conglomerate of Lungmen Series on the northwest of the village of Lung-

men as shown in Fig. 7. They are characterized with their upthrow sides all on the north of the fault lines and in the downthrow sides near the thrust planes there often appears a series of gash joints, indicating the direction of the thrust movement.

From the station of Men-Chai Railway to Liulichiu, the Chiulungshan formation being cut by the Hunho river, exposes a beautiful section (Fig. 3) in which occur three important thrust faults generally having some tendency to show the thrust force coming from north or northwest. The thrust plane is usually well exhibited with development of a series of compression joints (Fig. 8)

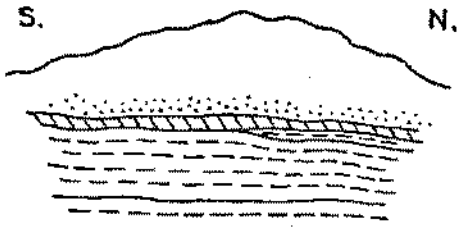

Fig. 8. Compression joints along a thrust plane, N. of Menchai Railway Station.

which can be readily explained by the planes of maximum shear of strain ellipsoid.

Another characteristic compression joints are exposed on the southwest of Hsihsinfang in the south side of the Mentoukou valley. Here the joints are developed in the Lower Yaopo Series in two predominant directions forming a series of strain rhombs in cross sections. The two joint directions evidently correspond to the two planes of maximum shear of strain ellipsoid under rotational stress. The direction of the stress seems from southwest though it may be locally caused by some local phenomena.

Coal Seams.

As shown in the above sections there are eighteen coal seams in more than one foot in thickness in the Lower Yaopo Series, at least one coal seam in the Upper Yaopo Series, and one seam in the Lungmen Series. The work-

able coal seams are, however, only five in number and all contained in the Lower Yaopo Series. The uppermost workable coal called Tzuerhtsao by the native miners is 13 ft. thick (see the boring section) and stratigraphically about 573 ft. distant from the top of the Lower Yaopo Series. From Tzeerhtsao downwards to the next workable coal seam called Heimeierhhsien by the natives, the Stratigraphic distance is 166 ft. This seam is about 5 ft. thick (see the boring section) and stratigraphically 257 ft. distant below from Heimeitahsien coal seam which is 9 ft. in thickness and which is again about 242 ft. distant below from Mingmeitahsien coal seam about 7 ft. thick. From the last coal seam down to the lowest workable coal so far as discovered, the distance is 313 ft. It is about 8 ft. in thickness but whether it is equivalent to what is called Chingmeitahsien coal seam is not sure, as no sample can be obtained from it in making a comparison with Chingmeitahsien coal now being worked.

From Tzuerhtsao downwards to the lowest fifth coal seam, the total stratigraphic distance is about 978 ft. and from the top of the Lower Yaopo Series to this seam it is about 1551 ft. Hence, if a shaft is sunk on the top of Lower Yaopo Series, all the five coal seams might be worked in different levels.

General speaking, among the five seams Tzuerhtsao is the thickest while Heimeierhhsien the thinnest.

As to the quality of the coals the authors have made detailed collections even from different sublayers of various coal seams from the new shaft of the Sino-British Mine. Little can be stated here unless careful chemical analyses will have been completed in future. According to the experiments of the native miners, however, Heimeitahsien is the best and Chingmeitahsien is the most inferior while other three are moderate between them. All are anthracite.