39. *Plant-Bed with the Cathaysian Flora of Kaizan-tung, Kanto-syô, Manchuria, and Its Relation to the Marine Permian Deposits.*

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This paper consists of two parts: Part 1. Field Observations, by R. Imaizumi, part 11. Remarks on the Geological Age of the Plant-Bed, by H. Yabe.

Part 1. Field Observations.

The Kiturin or Touman groups of Manchuria are thick complexes or groups of complexes mainly consisting of metamorphosed slates, with subordinate conglomerate and limestone. They are rarely fossiliferous and those previously found at Soron,⁽¹⁾ Yuchuan⁽²⁾ and Kaizan-tung are marine organisms.

The metamorphosed clayslates are usually well sorted, homogeneous mud rocks, sometimes containing pyrite pseudomorphs (near Imienpo, east of Yuchuan), or often chialstolite crystals. They are also frequently impregnated with earthy graphitic matter.

The Touman groups extends southwards into a part of North Kankyodô, Tyôsen, where a similar rock series exists, occasionally with marine fossils. This is the Piching formation of the Geological Survey of Tyôsen.⁽⁴⁾

Later field works and paleontological researches revealed the presence in these formations of Gotlandian (Ertaokou near Kiturin),⁽⁵⁾ Devonian (Nichiho),⁽⁶⁾ Shanhotun, and Hei-tai),⁽⁸⁾ and of Carboniferous-Permian fossils (Min-

(1) T. Kobayashi: Upper Palaeozoic Shells of Soron in the Great Khingan Range. Jap. Jour. Geol. Geogr., Vol. VIII, 1931.

(2) G. Asano: Geology and Geography of North Eastern Manchuria. Geol. Inst., South Manchurian Railway Co., p. 22, 1937.

(3) G. Asano: Report on the Chromite and Some Other Deposits near Kai-shan-tun, Ho-lung Prefecture. Bull. Geol. Inst., No. 97, p. 38, 1939.

(4) T. Ichimura: Kainei Coal Field. Rep. Geol. Surv. Coal Fields in Chosen, 1, 1932.

(5) H. Yabe and M. Eguchi: On a Limestone with Favosites from Erh-tao-kou, west of Kirin, Manchuria. Proc. Imp. Acad., Vol. XIX, p. 681, 1943.

(6) H. Yabe and T. Sugiyama: A Lower Devonian Faunule from North Manchuria. Proc. Imp. Acad., Vol. XVIII, p. 499, 1942.

(7) H. Yabe and T. Sugiyama: *Batostomella* (*Geinitzella*) from South China and Manchuria. Proc. Imp. Acad., Vol. XVIII, p. 681, 1943.

(8) H. Yabe: An Occurrence of Devonian Fossils in Manchoukuo. Proc. Imp. Acad., Vol. XVI, p. 555, 1940.

cheng⁽⁹⁾ on the Manchurian side, and Lunkomien⁽¹⁰⁾ on the Tyôsen side).

Whereas all the fossiliferous deposits of the above mentioned places are marine in origin, a bed rich in plant fossils has recently been found in the Touman group at Kaizan-tung, Kantô-syô. This discovery is important and worthy of special attention. The junior writer (R. Imaizumi) spent there some ten days in August 1942, for field work under the kind instruction of Prof. E. Konno of the Geological Institute, Kyûsyû Imperial University. According to Prof. E. Konno, the fossil flora evidently belongs to the Cathaysia or *Gigantopteris* flora, comprising its characteristic elements as, *Lobatoannularia*, *Sphenophyllum*, *Rhipidopsis*, etc., and above all many *Gigantopteris*.

There being no good topographical map of this district other than that of the Military Land Survey in the scale of 1:500,000 at disposal, the stratigraphy could not be worked in detail, the following description is but little more than notes of each exposure.

The railway extending from south to north along the Japan Sea coast of North Kankyô-dô, Tyôsen, branches at Kamisanbo. One of the branches turns west and crosses the river Touman, then runs on the alluvial plain of the river close along the foot of the forehills of the mountainland at the south; the first station is, Kaizan-tung and the second is Kaikei-gai. There are several small valleys dissecting the hills from south to north, two of which are worthy of special mention. One with the two villages Bunka-tung and Zidô-tung debouching midway between the railway bridge of Touman river and the station Kaizan-tung, and the other with the three villages Sinsô-hyô, Saisyû-dô and Rirido debouching midway between the stations Kaizan-tung and Kaikei-gai. The rocks are well exposed in the railway cutting at a little west of the railway bridge and at some 1 km ESE of the station Kaizan-tung, westwards of the station for a distance of some 2 km, being twice interrupted by the valley of Bunka-tung and Zido-tung, and another smaller one next to its west (Fig. 1). The east cutting shows the lowest strata visible in this field, which consists of phyllitic marly clayslate, homogeneous in texture, and light bluish gray in color; the color gradually changes to reddish purple upwards. Upwards this phyllitic slate insensibly passes to a clayslate, rich in pebbles of claystate of the same nature as the matrix, the color being reddish purple in its lower part and bluish gray in the upper. The pebbles lithologically similar to the matrix and indistinguishable from the underlying marly clayslate, are in general,

(9) H. Yabe and M. Minato: Eine *Aulna*-art aus der Mandschurei. Jap. Jour. Geol. Geogr., Vol. XIX, p. 147, 1944.

(10) U. Ushimaru: Explanatory Text to the Geological Map of Manchuria, Touman-Chiang Sheet. Geol. Inst. South Manchurian Railway Co., p. 5, 1932.

disposed horizontally or parallel to the stratification plane, variously spaced and sometimes closely packed together. They are small in size, being 1 cm in diameter and angular in shape, while those crowded are usually 3-4 cm long and 2-3 cm broad, flattened and round elliptical in plan. They are light bluish gray in the lower part of the clayslate where the matrix is reddish purple, and reddish purple in the upper part where the matrix is light bluish gray.

Fig. 1. Map of Kaizan-tung to show localities

In the greater part of this east cutting, the bluish clayslate strikes N 20° E, and dips 20-30° NW; the small topmost portion of the cutting is occupied by the basal part of the reddish purple slate. The two deposits, without any trace of physical break, are conformable with one another. The middle cutting which is separated from the former by the valley of Bunka-tung and Zidō-tung exhibits the same bluish gray clayslate, but in opposite dip.

The same bluish gray clayslate is also exposed on the west cutting, where its strike is N 30°E and the dip is 50-60°NW, thus apparently forming an anticline with the same rocks of the middle cutting.

1 2 1 1 2 3 4 Conglomerate: plant-bearing

Fig. 2. Schematic figure of the three railway cuttings south of the station Kaizan-tung

The bluish gray clayslate is overlain successively without physical break by a reddish purple clayslate, a reddish purple clayslate with pebbles, and at the top discordantly by a conglomerate in which plant remains are present:

The phyllitic clayslate of the east cutting is strongly disturbed at its eastern side, a tectonic line is assumed as passing along the course of the river Touman. Another tectonic line almost parallel to the former may exist along the valley of Bunka-tung and Zikô-tung (Fig 2).

A greenish colored fossiliferous sandy shale exposed in the valley of Bunka-tung and Zidô-tung, some 9 km above its mouth, is succeeded downward by a sandy slate with slate pebbles and a bluish gray clayslate with slate pebbles. The latter rests on a bluish gray clayslate likewise with

Fig. 3. Columnar section of the rocks of Kaizan-tung

is fossiliferous in another small valley next to the west of the valley of Bunka-tung and Zidô-tung, where the bed has a trend of N 70°E, inclining 55° to NW.

slate pebbles, which is apparently identical with that seen at the west cutting along the railway. At the fossil locality, the sandy slate has the strike varying from E-W to N 70°E, with the corresponding dips varying from 40° to N to 45° to NW.

The fossiliferous sandy slate is then followed by a blackish clayslate, 600-700 meters thick by estimation. This is the topmost member of the lower complex in the field concerned, unless the limestone, calcphyllite and schistose diorite in the valley of Kaikei-gai represents a higher horizon of the same complex (Fig. 3). These phyllitic rocks form there a syncline, in position as if being its upper members, though interrupted by a wide space without good exposures, of the black clayslate complex. This black clayslate

Summing up the observations mentioned above, there is a thick complex of various clayslates with marine fossils in two horizons. Their succession in ascending order is as follows.

1. Bluish gray clayslate
2. Reddish purple clayslate
3. Reddish purple clayslate with slate pebbles
4. Bluish gray clayslate with slate pebbles
5. Sandy clayslate with slate pebbles
6. Light greenish sandy shale: fossiliferous
7. Black clayslate: fossiliferous

At the west cutting along the railway, the younger complex which includes the plant-bearing conglomerate, rests directly on the 4) bluish gray clayslate with slate pebbles, thus lacking there at least the members from 5) to 7) of the lower complex. Moreover, the upper complex with the strike of N 45°E and dip of 50°NW, is evidently disposed somewhat differently from the underlying clayslate. The discordance between them is therefore to be regarded as a hiatus not only erosional but also diastrophic. It must be, however, added that their actual boundary later possibly suffered a farther disturbance, and also that part of the bluish gray clayslate lying directly beneath the plant bearing conglomerate is darker colored and more hardened than the rest of the same slate, and has its stratification indistinct.

The plant-bearing conglomerate can be subdivided as follows in descending order.

- Conglomerate 5 m.
- Black shale 1 m.
- Conglomerate 2 m.
- Black shale 1.5 m.
- Sandstone 7 m.
- Black shale with plant fossils, 1.5 m. Disposed N 60-65°E, 60-65° to NW.
- Conglomerate, 50 m.
- Conglomerate gradually changing into sandstone in its upper part, 10 m.
- Conglomerate, much disturbed, having several layers of black shale, 50-60 cm thick, and occupying a thickness of some, 20 m.
- Conglomerate, 5 m.
- Gray shale (reformed shale?), reddish purple in its lower part, 2 m.
- Conglomerate, 2.5 m.

The apparent thickness of the conglomerate complex is nearly 400 meters, and the fossiliferous shales are at some 120 meters above its very base.

1.5-3 meters thick layers of black shale and also thin layers of coaly shale and sandstone are interbedded in the complex. The whole is more or less disturbed, but it is not certain whether the limited lateral extension of these thin layers in the conglomerate complex is primary in origin, or rather due to secondary disturbances. The above mentioned order of rock succession is only provisional, and many improvements by future field observations are required.

In general, the conglomerates embrace well-rounded, water-worn pebbles of granites, gneisses, quartz-porphyrries and clayslates, ranging from man's head to fist size. Granite boulders are especially common. The matrix is medium-grained arkose sand.

The nature of the sediments indicate that the younger conglomerate complex is terrestrial, most probably a torrential deposit, and belongs to a cycle of sedimentation different from that of the underlying clayslate complex. The latter can be subdivided into two parts, the upper comprising the black slate and the lower the gray slates. The two parts are intervened by clayslates of variegated color and with slate pebbles, the so-called desiccation or intraformational conglomerate indicating a flat-shore deposition of fine mud. The conglomerate is unconformably overlain by reddish-sandstones belonging to the Mesozoic Talatzu series.

A conglomerate exposed at 2.5 km south of Mushiho, Chiuta district in Kiturin province, much resembles the plant-bearing conglomerate of Kaizan-tung, though it has been regarded by Manchurian geologists to be Mesozoic in age.⁽¹¹⁾ It is fairly thick with well-rounded boulders of granites, basic igneous rocks and also of limestones, and thin layers of black shales are interbedded in it. It is traversed by andesite dykes thought to be of Mesozoic age. The limestone boulders are sometimes crowded, and they not seldom contain stem-joints of crinoids and some other fossils.

(11) G. Morita: Tertiary Plant Fossils, New Localities and Remarks. Jour. Geol. Soc. Manchuria, Vol. IV-V, p. 44, 1943.