Geomorphological Surfaces in the Kōriyama Basin, Fukushima Prefecture

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I. Preface

The Kōriyama Basin lies about 15 km to the east of Lake Inawashiro. The author made his field survey of this basin in 1961 and 1962. In this paper he is going to describe the nature of fan-like surfaces and others in the basin. The purpose of his study is a contribution to the increase of the data on the nature of the geomorphological surfaces.

In the basins of Tohoku District, many fans are developed, and those there are many studies by geomorphologists and geologists. Y. Tomita once made a remark that even in the Main Island of Japan, there might be such eroded fans as those of arid regions. He mentioned that it was hard to confirm it simply because of the deficiency of the outcrops showing the structure of fans, in connection with his study on the fans of Formosa (1951).

Although the present author does not wholly agree with Y. Tomita's opinion, the present author has reached to the conclusion that some of fans in the Tohoku District are accumulated fans, while the rest are eroded ones.[1] He published a paper in 1961 on the study of the Maemorihara Plain, to which Y. Tomita referred as an example of such above-mentioned. There the surface is fan-shaped, and the fan deposits is thin. The deposits are chiefly composed of gravels or boulders of granite, this suggests the possibility of the formation of the fan under the lithological control.

The present author thinks that the influences of tectonic movement has been overestimated in the studies of the land forms of Japan. As stated by K. Kobayashi (1962), fluvial accumulation may be influenced by both tectonic movements and climatic changes, though in Japan where tectonic movements have occurred frequently it is hard to confirm whether the dominant cause of accumulation is attributable to the former or the latter.

We may try to approach the problem of stream accumulation from the view-

1) In this paper the author follows Y. Tomita's terminology.
Eroded fans mean that they have only a little of deposits, or veneer of alluvium or gravels, and their basements have shapes of fans. Accumulated fans are rather aggradational ones and the basements does not have the shapes of fans in general.

point of climatic change, although it is difficult to make clear such a problem in the non-glaciated regions.

It is well known that since the close of the last century many studies have been published on lateral planation, sheet wash, or in other words, on erosion terraces, fans, and pediments. Also many works have been done on stream accumulation or stream terracing. The author regards that both lateral planation or sheet wash and stream accumulation are in the same scope of the problem. Even in the region where tectonic movements are unexpected, opinions on the problem are various, especially in the cases of the inland and the non-glaciated areas. In those two areas just referred, if any opinion in proposed on such a problem, the evidence which the opinion based on is sometimes very poor (C.A. Cotton, 1945), and it may be said that there is no established theory for the problem yet (J.C. Frye, 1961).

As H.T.U. Smith pointed out in his referrence to stream terracing (1949), that it was necessary not to discuss on the problem but to accumulate data in number and in kinds, which related each other.

II. General Description of Topography and Geology[2)]

The Kōriyama Basin is one of a series of basins situated from the north and to the south between the Ōu Mountain Range and the Abukuma Mountains. The eastern margin of the basin is bounded by the western side of the Abukuma Mountains which is chiefly composed of schist and granitic rocks.

To the west of the basin there is the Ōu Mountain Range which embraces a lake basin Inawashiro, and its eastern side, i.e. the west margin of this basin, is composed of granodiorite, propylite, and Tertiary sediments. The northern and southern margins of the Kōriyama Basin are bounded by the hills composed of Tertiary sediments and liparite. Tertiary sediments in this area consist of tuff, tuffaceous shale and sandstone, and in some parts there are tuffaceous sediments with pyroclastic facies.

The Quaternary system of this basin consists of the Kōriyama Formation and terrace deposits. The Kōriyama Formation is also a kind of terrace deposits, however, the formation is very thick and of various geological interests, then the formation has been treated separately from other terrace deposits by the preceding papers in general. In this paper the author describes the formation in the section of the geomorphological surfaces.

The drainage pattern of this basin is asymmetrical east and west. The Abukuma River flows northwards along the eastern margin of the basin and the

2) The description of geology is mainly based on M. Watanabe et al (1934): Geological map of Fukushima Prefecture 1: 200,000.

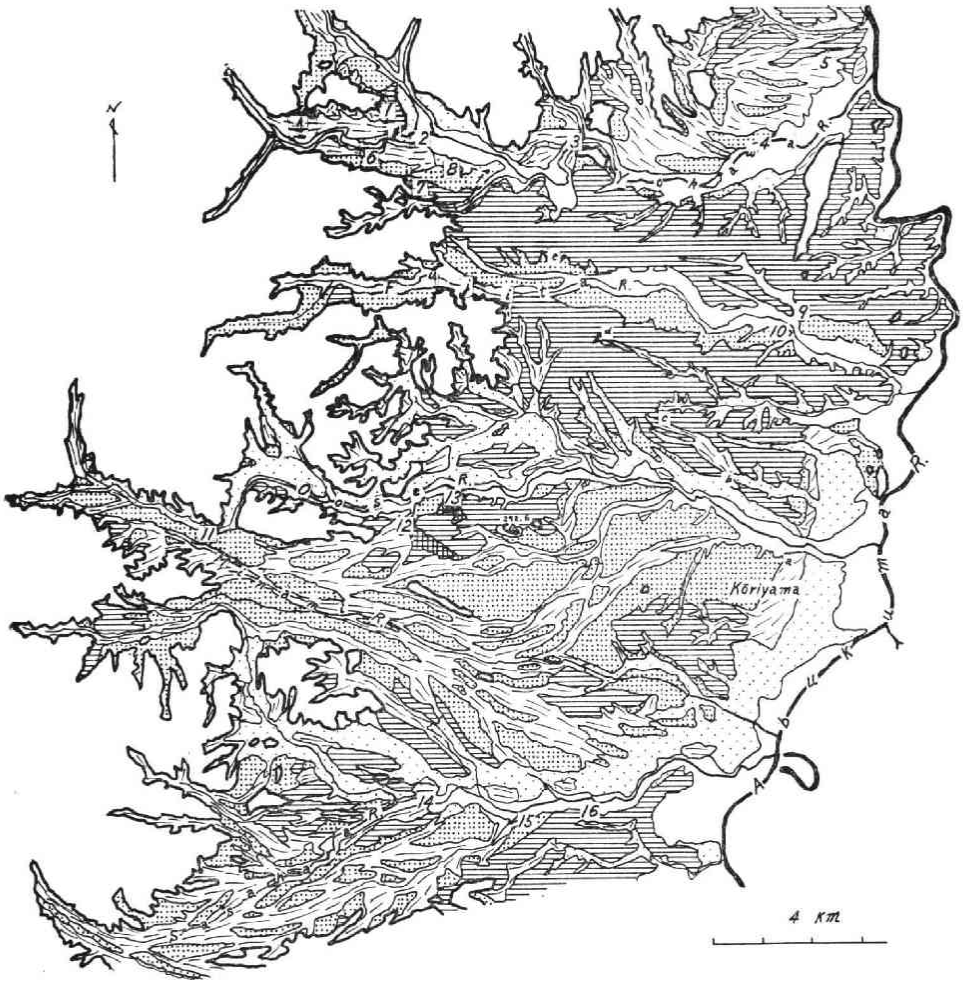

Fig. 1. Distribution of Geomorphological Surfaces.
1 — 12: Locality Numbers of Geological Sections.
a — i: Sites of Bench Marks.

Mountain & Hill
Shōbune S. & Kōriyama S.
Mihota S.
Upper Ōtsuki S.
Kōtanbara Surface
Lower Ōtsuki S.
Lowest Terrace & Flood Plain

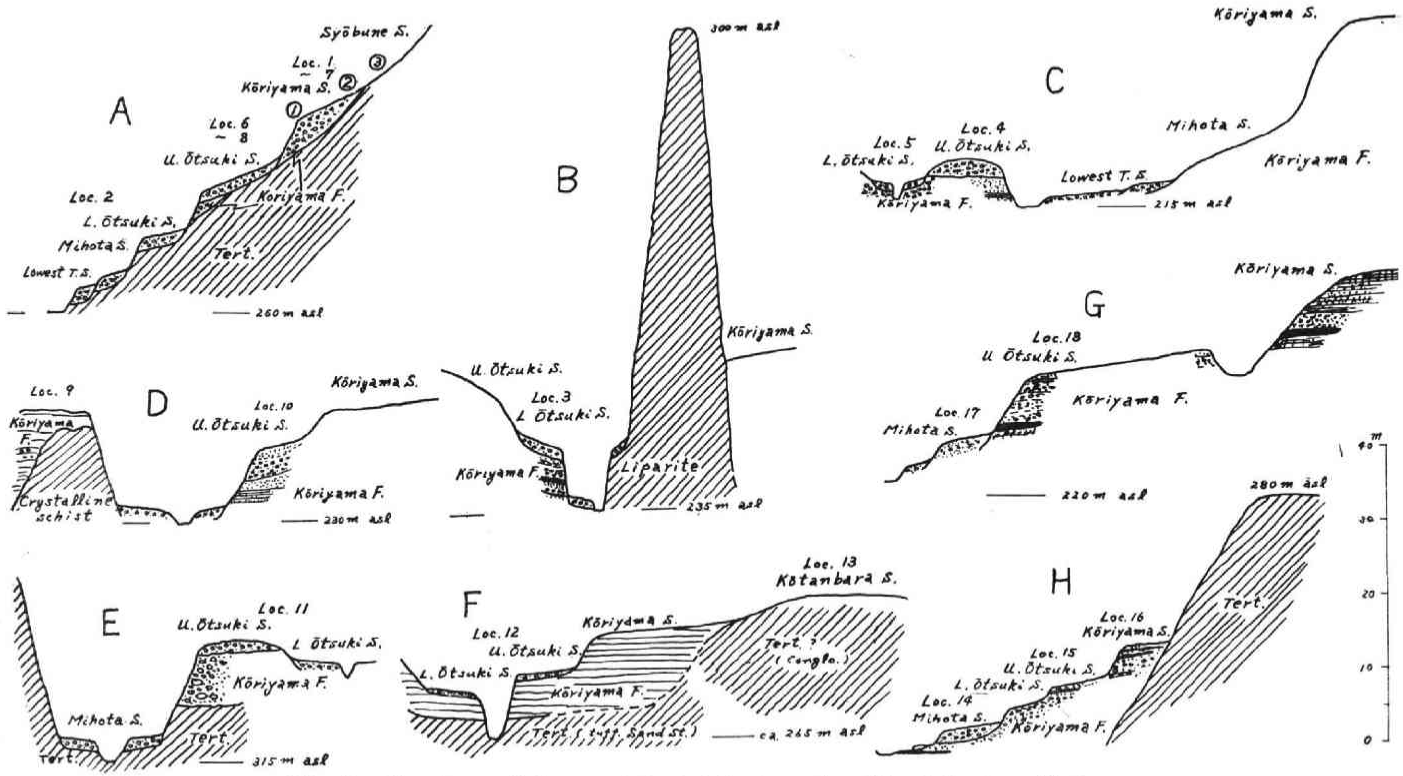

Fig. 2. Structures of Geomorphological Surfaces (see Fig. 1 for Localities).

majority of its tributaries flow into it from the west. Among the tributaries the Yokawa, the Ōse, and the Sasahara Rivers are larger ones, and the Fujita and the Minami Rivers are smaller ones. Besides them there are numerous artificial channels of the Asaka Irrigation System which have conducted the water of Lake Inawashiro to this basin since 1881.

III. Descritption of Geomorphological Surfaces and the Materials underlying them

The author has classified the surfaces into seven, those are Kōtanbara Surface, Shōbune Surface, Kōriyama Surface, Upper Ōtsuki Surface, Lower Ōtsuki Surface, Mihota Surface, and Lowest Terrace and the present flood plain. In addition to those there is a gently inclined, sometimes rolling, upland surface with relict red soil on it. But in this paper the author does not describe the upland surface.

The nature of the surfaces and the material underlying them are as follows.

(1) Kōtanbara Surface

The top of the Surface is level to slightly convex and is, in general, several meters high from the top of Kōriyama Surface. The rim of this Surface is concave and intersects with Kōriyama Surface. In other words, the lower part of the rim immerses under Kōriyama Surface (Fig. 2). The material underlying the surface is weathered Tertiary conglomerate or sandstone with a thin soil and subsoil at the top. In the uppermost part, 1 m to 1.5 m thick, of the section of road-cutting at Loc. 13, the matrix of the conglomerate is red purple or deep red purple.

(2) Kōriyama Surface and Shōbune Surface

Kōriyama Surface ranges 240m to 270 m above the sea-level and the underlying material is those of the Kōriyama Formation.

The Kōriyama Formation consists of loose gravel, sand, silt, clay, and peat (Figs. 2·3). The thickness of this formation has not been ascertained. Two borings[3] to search groundwater evidence that such loose materials exceed 80m in thickness and that peat layers occupy the upper horizons of the boring columns and underlying horizons consist of alternation of gravel and sand.

As to the Kōriyama Formation, the author will discuss in a later paragraph.

Shōbune Surface is a gentle slope and the underlying material consists of breccia and sand. At the type locality Loc. 1, the material transits into the

3) One is bored at 3 km to the northeast of Kōriyama City from the surface of the author's Mihota Surface for a chemical work. Another is bored within Koriyama City from the surface of the author's Lower Ōtsuki Surface for a hospital. If those borings were done from Kōriyama Surface their depths surely exceed 100 m.

superficial layer of the Kōriyama Formation (Fig. 4). The surface also transits into Kōriyama Surface without break. So, the age of the formation of this gentle slope is same as that of Kōriyama Surface.

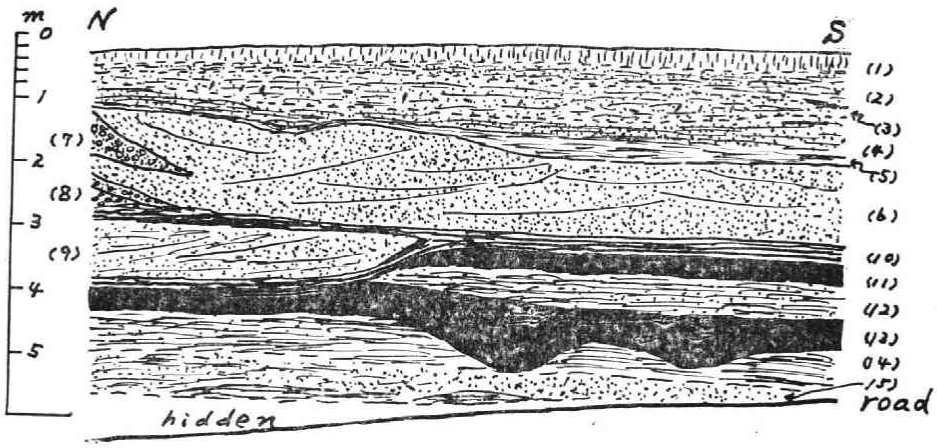

Fig. 3. An Example of the Upper Horizon of the Kōriyama Formation: Section of Road-cutting at Loc. 16.

Explanation — (1) Brown subsoil. (2) Light grey, massive tuffaceous silt. (3) Grey clayey silt with many limonite nodules. (4) Dark grey clay. (5) Grey clay with Liesegang bands. (6) Brown, cross-bedded coarse sand with gravels smaller than 5 mm in diameters. (7) & (8) Gravel lenses composed of gravels with diameters from 1 cm to 3 cm. Gravels and sand matrix are cemented with limonite. (9) Cross-bedded sand. (10) Limonite pan. (11) Peat. (12) Coaly clay. (13) Peat. (14) Coaly clay. (15) Brown sand. The lower part of its graduates into grey silt.

(3) Ōtsuki Surfaces, the Upper and the Lower.

When the Upper and the Lower Surfaces are united as one surface, it represents a form of fan. Then, sometimes it is denominated as Ōtsuki Fan (H. Yasuda, 1938; Koriyama Quaternary Research Group, 1962).

Seen from the distribution and the structure, both the Upper and the Lower Surfaces resemble each other. They differ only a little in their height.

The forms of those Surfaces are terrace-like along the large tributaries such as the Yokawa, the Ōse, and the Sasahara Rivers, and on their interfluves those Surfaces present digitated forms in their plan. Along the main stream they develop little.

The characteristics of the structures of those Surfaces consist in the deficiencies of the deposits. Along the upper reaches of the tributaries they have a veneer of gravel, while along the lower ones they have no deposits except the weathered products of the bedrock, Kōriyama Formation (Figs. 2·5). The weathered

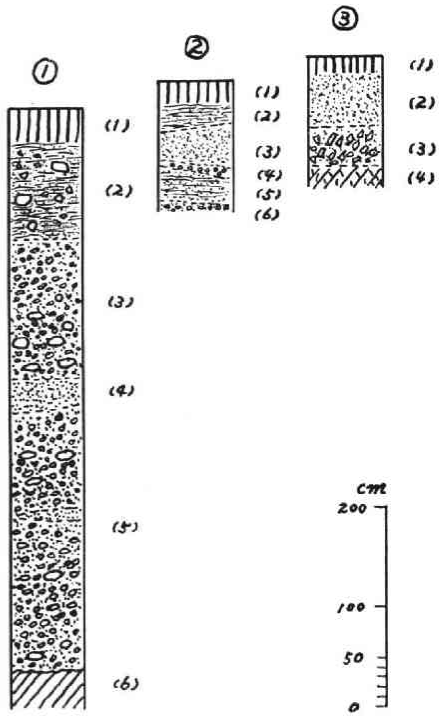

Fig. 4.

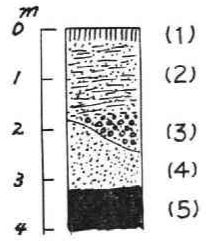

Fig. 5.

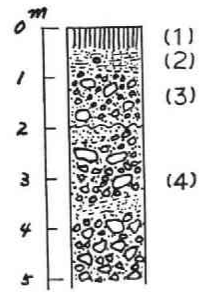

Fig. 6.

Fig. 4. Geological Columns showing the Relation of Deposits underlying Shōbune Surface and Kōriyama Surface at Loc. 1. The sites of the columns correspond to the same numbers shown on Fig. 1–A.

① (1) Black surface soil. (2) Light brown clayey silt dotted with gravels and subangular breccia with diameters from 3 cm to 25 cm. (3) Gravel bed composed of limonite-coated gravels with diameters from 3 cm to 5 cm in common, rarely 20 cm. Lithology of each gravel is same with those of (5). (4) Slightly laminated, compact sand bed. (5) Slightly laminated gravel bed with sand lenses. Gravels are from 3 cm to 25 cm in diameters and propylite, granodiorite, and sandstone in lithology. All of them are completely decayed. (6) 2 m (plus) bedrock, tuffaceous sandstone.

② (1) Black surface soil. (2) Brown sandy clay. (3) Brown, coarse sand. (4) & (6) Gravel lenses. Gravels are from 5cm to 10cm in diameters, and are coated with limonite and completely decayed. (5) Slightly laminated sand.

③ (1) Black surface soil. (2) Orange brown coarse sand with small fragments of sandstone. (3) Weathered sandstone orange brown in colour. (4) 30 cm (plus) brecciated tuffaceous sandstone.

Fig. 5. Section at Loc. 10: Explanation-(1) Black surface soil. (2) Yellowish brown clayey silt. (3) Gravel bed composed of gravels from 1 cm to 4 cm in diameters. Each particles are cemented with limonite each other. (4) Brown sand. (5) 1.5 m (plus) coaly silt.

Fig. 6. Section at Loc. 11: Explanation-(1) Black surface soil. (2) Brown sandy loam with a few gravels 5 cm to 15 cm in diameters. (3) Greyish, loose gravel bed with sand matrix. Gravels are from 2cm to 25cm in diameters and propylite and sandstone in lithology. (4) 450 cm (plus) reddish brown gravel bed with coarse-sand matrix. Gravels are from 5 cm to 40 cm in diameters, and round and subangular in shape, and granodiorite, sandstone, and propylite in lithology. Each gravel is completely decayed.

products, of course, may have been moved downstream a little. The deposits along the upper reaches of the tributaries consist of sorted gravels and sand, silt (Fig. 6), however, at some places, for example at 2 km to the southwest of Loc. 12, they are composed of subround gravels of granodiorite and propylite with diameters from 50cm to 5cm. Regardless of the lithology and the size such gravels are fresh.

(4) Mihota Surface

The author could not know exactly the structure of this surface, but some exposures suggest that it resembles those of Ōtsuki Surfaces.

(5) Lowest Terrace and the present flood plain

The Lowest Terrace may be subdivided into two or three, but the boundaries are generally meander scars and the terrace deposits are very loose. Such features are different from those of the upper surfaces. However, the bedrock, Kōriyama Formation, outcrops at the base of the scarp of the bank, about 3 m heigh, so it is evident that the terrace deposits are very thin. This terrace develops also along the main stream.

In the distribution map of geomorphological surfaces, Lowest Terrace and the present flood plain are combined, for the lowest level of the former transits into the latter.

IV. Tectonic Movements

The distribution of isolated hills and rock masses surrounded by the Kōriyama Formation suggests the possibility of tectonic origin of this basin. Some surfaces of the hills have breaks in their sky-lines and those suggests tilting of the hills. Some of the river courses seem to follow fault lines. Recent earth movements in this basin is shown in Fig. 7.

Each surfaces, however, has not been influenced by the tectonic movements

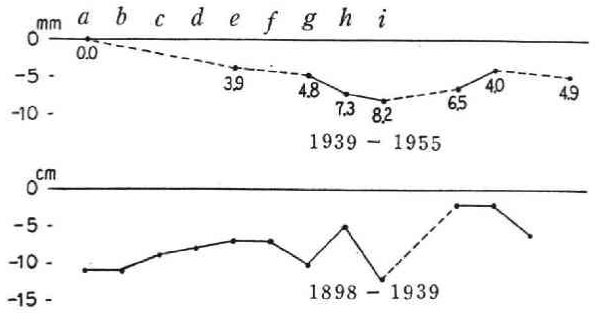

Fig. 7. Values of the Recent Earth Movement in the Kōriyama Basin, after the Results of Levellings by the Geographical Survey Institute of Japan. a — i: Sites of Bench Marks (See Fig. 1)

in so far as to cause abrupt changes the structures of them (Fig. 2).

V. Climatic Changes suggested by the Nature of the Kōriyama Formation

The Kōriyama Quaternary Research Group (1962) and K. Suzuki (1962)[4] studied the plant fossils imbedded in the upper part of the Kōriyama Formation and summarized as follows:

The sequence of the plant fossils suggests a climatic alternation from cold to cool (warmer) and to cold from the lower to the upper within the upper layers[5] of the Kōriyama Formation. Most geologists in Japan regard tentatively the Formation as of the age of Riss-Würm interglacial, however, the uppermost part may not be of the interglacial.

The author's observations on related features are as follows. The gravels of the Kōriyama Formation at Loc. 11 are thoroughly weathered and particles of granodiorite are red purple (Fig. 6). The matrix of the gravel bed underlying the deposits of Ōtsuki Surface at Loc. 8 is light red. As the Research Group has pointed out, Kōriyama Surface to the northeast of Loc. 9 has been more dissected than the Kōriyama Surface proper, and the former is a little higher than the latter. Peat layers are predominantly imbedded in the Formation at the central part of the basin. General absence of peat layer at the western part may be due to the fluvial condition at that period, that is to say, the upper reaches of the tributaries were less aggradational or less stagnant than their lower reaches, or near the main river.

Judging from such features, the author thinks that so-called Kōriyama Formation is subdivided at least into two, and the Formation exhibits a basin structure. That is, such parts as is situated to the northeast of Loc. 9 are formed with relation to a higher base-level of deposition, and after the period the base-level slightly lowered and the Kōriyama Surface proper was formed. Probably at the time between the former and the latter, a warmer climate prevailed and the weathering of a part of the dried-up deposits greatly proceeded according to their lithology, and some parts of them became red-coloured. Probably, before or during the warmer period, Kōtanbara Surface was formed and red soil developed on them as well as on the hill.

An evidence to support the author's idea is the section and the absolute age of peat seen in the section at Loc. 12 (Fig. 8).

4) K. Suzuki is the leader of the Kōriyama Quaternary Research Group.

5) It must be kept in mind that we are able to observe the exposures and to collect samples only of the upper part of the Kōriyama Formation. The maximum depth observable in the exposure is about 20 m.

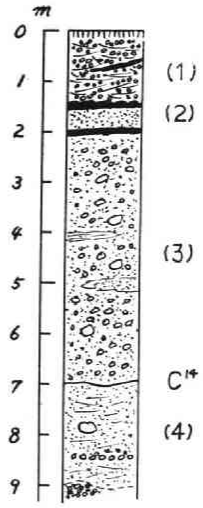

Fig. 8. Geological Column at Loc. 12.
Explanation — (1) Grey, loose gravel bed with clayey silt lens. Gravels are 3 cm to 10 cm in diameters. (2) Coaly clay inlayed with a fine sand layer. (3) Orange brown, compact gravel bed with sand lenses. Gravels are smaller than 25 cm in diameter. (4) Slightly cross-laminated coarse sand with gravels. Partly Liesegang bands develops.
Layer (1) is the deposits of Upper Ōtsuki Surface. "C14" in the columus is the horizon from which the sample is collected by K. Suzuki and dated by radio-carbondating.

According to K. Suzuki, the age of the deposition of the peat layer at the lowest part of the old gravel bed at Loc. 12 is 25,000 B.P. The lower end of this bed seems to show a small hiatus. The lateral tracing of the peat layer of this site to the peat layers examined with the pollen analysis by K. Suzuki cited above was not done yet by him and his collaborators. Probably the tracing is difficult because such peat layers are not necessarily successive and exposures are deficient.

The development of Shōbune Surface and the uppermost layer containing breccia of the Kōriyama Formation may have the same significance as in the Sarugaishi Valley (T. Wakō, 1963).

VI. Significance of Ōtsuki Surface

It is clear that the base-level of erosion was lowered successively from that at the stage of the Kōriyama Surface to that at the stage of Upper Ōtsuki Surface and to that of the stage of Lower Ōtsuki Surface and so on. In accordance with such lowering of the base-level of erosion the gradients of the tributaries became steeper (Fig. 9). And the conditions of the tributaries became degradational. Such

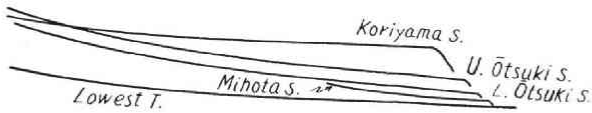

Fig. 9. Schematic longitudinal Profiles of each Surface.

conditions seem to be inherited by the rivers at the period of Mihota Surface.

For the lateral planations which formed such surfaces with a little or no deposits

as both Upper and Lower Ōtsuki Surfaces, the geological structure was surely favorable, that is because the distribution of hard rocks in the upper valley of streams and soft rocks, Kōriyama Formation, along the middle and lower courses eased the lateral planation.

The author assumes the occurrences of sheet washes, especially on the formation of Ōtsuki Surfaces in the lower reaches of the tributaries. The materials of the Kōriyama Formation are less permeable, then the nature might contribute to the occurences of sheet washes (J. Bourcart, 1957).

Tectonic movement did not produce aggradational conditions in these stages, and it differs from the conditions in the Fukushima Basin situated to the north of this basin (K. Fujiwara, 1958).

Referring to the geomorphological, geological, and archaeological studies in Japan, it is sure that the formation of the Lowest Terrace is in the Holocene. As to the age of the formation of Mihota Surface, there is no indication to date it. Based on the lithofacies of the deposits, the author estimates that the hiatus between the formations of Kōriyama Surface and Upper Ōtsuki Surface and between those of Upper and Lower Ōtsuki Surfaces are less than that between the formations of Lower Ōtsuki Surface or Mihota Surface and that of the Lowest Terrace. Although the estimate has to be examined by the subsequent studies, the estimate and the features of both Upper and Lower Ōtsuki Surfaces including the facts about the Kōriyama Formation lead the author to the following conclusion.

After the deposition of the top layer of the Kōriyama Formation around 25,000 B.P., the favorable climatic conditions for the development of eroded fan prevailed and both Upper and Lower Ōtsuki Surfaces are formed. The geological conditions are favorable for such development of the surfaces in addition to the climatic conditions. As Y. Tomita suggested as cited above, and as H.v. Wissmann (1951) described that the conditions on fluvial processes of subglacial stages are the same as arid ones, the climatic conditions at those two stages in the Kōriyama Basin may be periglacial and the formations of such eroded fans may be attributable to intermittent runoff of water. Y. Kaizuka's deduction (1962) supports the idea.

VII. Conclusion

The Quaternary history of the Kōriyama Basin is summarized as follows.

(1) After the formation of Upland Surface, the Kōriyama Formation was deposited. Probably the outline of the basin for the deposition of the Formation was decided by tectonic movement.

(2) The Kōriyama Formation may be subdivided into two or more. The

uppermost layer is tentatively correlated with the deposits of Terrace 1 along the Sarugaishi River (T. Wakō, 1963). The deposits underlying unconformably the top layer suggest a warmer climate, and in this period the red soil is formed on Kōtanbara Surface. Dried-up deposits of the Kōriyama Formation are also weathered and some of the deposits became red-coloured.

(3) The formation of the red soil on Upland Surface may be at the same age as that of red soil on Kōtanbara Surface, for red soil is developed on the side slope as well as on the top of Upland Surface. According to the author's reconaissance of the geomorphological surfaces in a part of the Abukuma Mountains just to the east of the basin there is an upland surface underlain with deeply weathered granodiorite, and block fields are developed at a lower level. From such a veiwpoint, the upland surfaces in this area are tentatively correlated with Upland Gentle Slope along the Sarugaishi (T. Wakō, 1963).

(4) The top layer of the Kōriyama Formation is deposited since 25,000 B.P., and a little later two storied eroded fans, Upper and Lower Ōtsuki Surfaces, are formed. The climate prevailed in the stage as well as in the stage of the deposition of the top layer cited here may be periglacial. Two storied eroded fans may be correlated with "af plain" of the Kitakami Valley (T. Wakō, 1956).

(5) To such geomorphological processes, tectonic movements were less influential.

Acknowledgement

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