

## Geology of the Kurehayama Hills

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### 呉羽山丘陵の地質

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呉羽山丘陵は富山平野の中央にあり、北東-南西方向に走り、富山平野を二分している。東側の急崖には新第三系の西富山砂岩層、安養坊砂・泥互層、長慶寺砂層が分布し、西側の緩斜面には更新世の呉羽山礫層、峠茶屋礫・砂泥互層、西金屋砂層、北代砂層、友坂礫層、境野新扇状地礫層が分布している。

1961年の藤井・坂本の論文以後、呉羽山丘陵を横切る道路やトンネル、また多くの建築物による、たくさんの切割ができて地質の多くの情報が得られたので、それらの情報をまとめた。すなわち1961年以後新しくつけ加えられた主な事項は次の諸点である。

1. 安養坊砂泥互層から多くの海棲軟体動物の化石が得られ、それらは時代的に大桑層の化石と対比される。
2. 亜高山帯性の植物化石が峠茶屋層と西金屋層の上部から得られ、それぞれミンデル、ウルム氷期に対比される。当時の平均気温は約7℃低下していた。
3. 呉羽山火砕岩層は西金屋砂層、友坂段丘礫層は友坂礫層とそれぞれ名称を変更した。
4. 呉羽山断層は露頭をみつけないことはできないが、呉羽山の形成史や呉羽山から東の地下構造を考えると推定される。また友坂断層も顕著な活断層である。

Geology of the Kurehayama Hills is treated in this article. Geological system of the hills is classified as table 1. Neogene Tertiary group is distributed in the east steep slope, and Quaternary group is distributed in the west gentle slope and tableland.

The differences between former paper (FUJII and SAKAMOTO, 1961) and this paper are as follows;

1. A lot of cold type of floral remains and some marine mollusks fossils are found recently.
2. The age of the Kurehayama Hills is made clearer than the former by finding a lot of fossils.
3. Details of geological cross sections are got for crossing roads of hills and

- building roads and many houses.
4. Name of Kurehayama pyroclastic rocks member is changed for Nishikanaya sand member.
  5. Tomosaka terrace gravel member (1961) is also changed for Tomosaka gravel member and its distribution extends to the north part.
  6. Kurehayama fault and Tomosaka fault are described.

## I Introduction

The Kurehayama Hills are located in the central part of Toyama Prefecture and separates it into Goto (the east place from Kurehayama Hills) and Gosei (the west place from the hills). Joyama is the highest point (145.3m high) and Kurehayama (73m high) is the another high point in the north part of the hills. The hills are arranged from the north east to the south west trend. The east side of the hills has a steep slope and another side of the hills has a gentle slope. And the former has well outcrops and the later has ill outcrops. There is a tableland in the west side and gullys dissect the tableland. Recently many houses are built in this area as a suburbs of Toyama City. Sakainoshin alluvium fan is located in the south part of the hills between the Kurehayama Hills and the Imizu Hills. The west slope of the hills has used for orchards. Kurehayama fault runs along the east side of the hills. S. FUJII (1958) described them geologically. One tunnel was dug into the Kurehayama Hills for Hokuriku Line on 1959. Then FUJII and SAKAMOTO (1961) described and discussed the development of the Kurehayama Hills. Formerly already T. Tsujimura (1926) discussed the fault scarp of the east side. And W. ICHIKAWA (1932) also discussed the topography of Kurehayama Hills. He considered the block movement was important for development of this hills. K. Ida also discussed that the cause of a steep cliff in the east side was river erosion. FUJII et al.(1972, 74) found a lot of flora remains showing cold climate at the west side of the hills.

The hills have been located in the important place between fan deposits of the east area and swampy deposits of the west area in the Toyama sedimentary basin during Quaternary age.

After 1961, two roads crossed the Kurehayama Hills and a lot of outcrops are made for building, roads and houses. Many floral remains and marine fossils were found and many geological informations increased during these several years. In this paper, the recent geological informations of the Kurehayama Hills were compiled.

We express our thanks to late Professor S. Miki who diagnosed floral species kindly. Also we express our gratitude to N. Nishio, H. Tsuji and H. Watanabe who helped us in the field survey.

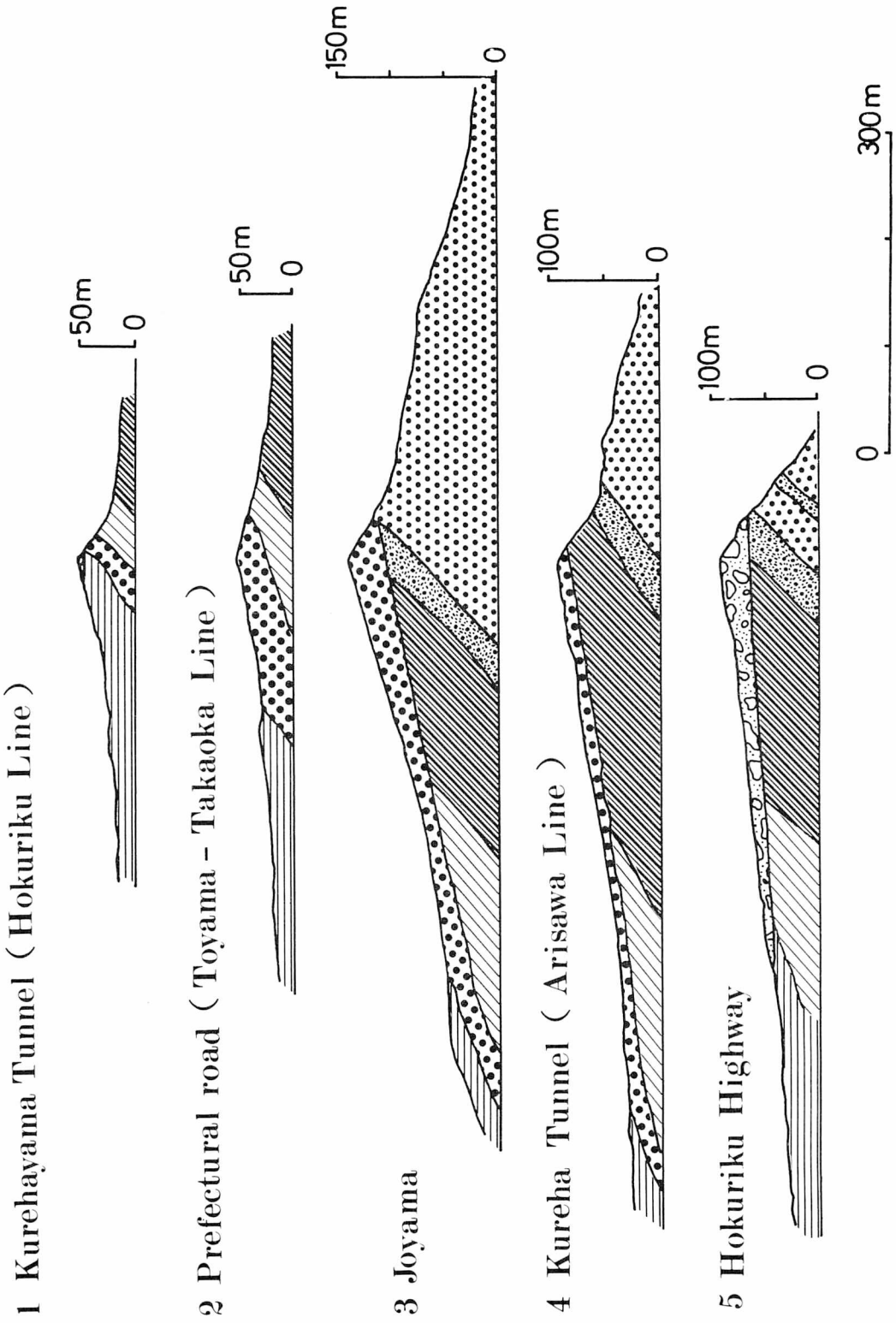


Fig. 1b. Geological profiles of Kurehayama Hills

## II Description of geology

Stratigraphical succession of Kurehayama Hills is shown in table 1. Neogene Tertiary group consists of marine deposits, and locates at only steep cliff of the east side. Quaternary group consists of terrigenous fan and lake deposits, and locates at the west slope of the hills.

Table 1. Geological System of Kurehayama Hills

Holocene		Alluvium deposits	lake and fan deposits
Pleistocene	Würm Glacial	Sakainoshin alluvium fan gravel member Tomosaka gravel member	fan deposits
	R/W Intergl.	Kitadai sand member, Nishikanaya sand member	
	Mindel Glacial	Togechaya gravel, sand and mud alternation m. Kurehayama gravel member	lake deposits fan deposits
Pliocene		Chokeiji sand member An'yobo sand and mud alternation member Nishitoyama sandstone member	marine deposits

### 1. Nishitoyama sandstone member

Type locality: Outcrop behind Nishitoyama station of Takayama Line. Distribution: This member is distributed in the south-east cliff of the hills. Stratigraphy: This member is the lowest part of Neogene Tertiary and it is unable to know lower limit of the member in this area. Rock materials: Massive muddy fine sand with bluish grey to black grey colour at fresh part and yellowish brown colour at weathered part. It has "brushing texture". Coarse pumice tuff layer with biotite is dominant at the upper most part of the member. This pumice tuff layer is divided into two layers in some localities and it becomes good key bed in this area. A few marine mollusks have found in this member.

At Nishitoyama

*Natica* sp.

At Tomosaka.

*Limopsis* sp.

Near the student dormitory of Toyama University.

*Turritella* sp.

### 2. An'yobo sand and mud alternation member

Type locality: Quarry of An'yobo, cliff behind the Toyama Museum of Historical Materials. Distribution: Type locality, quarry of the north place of national road, along the road to the Kureha Heights, cutting of the Hokuriku Highway and Tomosaka. Stratigraphy: This member overlies the white pumice with slightly erosion surface and

## Geology of the Kurehayama Hills

underlies by the Chokeiji member. Rock materials: Lower part of the bed consists of greyish white homogenous massive sand and mud stone, middle and upper parts of the bed consist of alternation sand and mud. Unit of alternation is 40–100cm thick greenish brown fine sand and 3–5cm thick yellowish brown mud. Dip strike is N 40°–60°E, 30°–50°W. Sometimes reverse faults, horizontal faults and ripple marks are seen in the bed. Fossil: There are many sand pipes with 1–2cm in diameter. Some marine mollusks are found in the condition of cast and mold.

At the quarry of the north place near the prefectural road.

*Pecten kurosawaensis*

At the cliff behind the Toyama Museum of Historical Materials.

*Yoldia* sp.

*Megayoldia thraciaeformis gratiosa*

*Macoma calcarea*

*Lunatia* sp.

At Tomosaka

*Chlamys nipponensis*

*Patinopecten kurosawaensis*

*P. yessoensis*

*Clementia vathleti*

*Vasticardium* sp.

*Cyclina* sp.

*Gomphina* sp.

*Macra* sp.

*Lutralia* sp.

*Macoma calcarea*

*Tellinella* sp.

*Panope japonica*

### 3. Chokeiji sand member

Type locality: A cliff near the Gohyaku Rakan. Distribution: Tomosaka and type locality, new Kurehayama tunnel of the Hokuriku Line. Stratigraphy: This is the upper most member of Neogene Tertiary in this area. The member overlies An'yobo member with conformity and underlies unconformably Kurehayama member. Rock material: Yellowish brown to pale brown, massive fine to coarse sand with 1–3m thick gravel layer. These gravel consist of 2–10cm size pebble to cobble and the variations of their

rocks are granite, quartz porphyry, andesite, chert etc. The gravel bed erodes lower bed. A tuff with pumice intercalates lower part.

#### 4. Kurehayama gravel member

S. IMAMURA (1932) called the gravel member which was distributed on the Kurehayama Hills, Kurehayama gravel member. Type locality: A cliff along the road from An'yobo to Kurehayama. Distribution: Kurehayama and Joyama. Stratigraphy; The member overlies Neogene Tertiary group with unconformity and the member underlies the Toge-chaya member. Rock materials: Unconsolidated gravel intercalated sand layers. Rock kinds of gravel: Quartz porphyry, andesite, granite, chert, sandstone and conglomerate of Mesozoic Tetori group. Roundness of gravel is round to subround. Size of gravel is 5–30cm, ill sorting. Matrix is muddy coarse sand, thickness of sand layer is 0.3–3m. Most of gravel except quartz porphyry ones are rotten. Pink tuff with high quartz crystal, its thickness is about 3m, intercalates the upper part of the Kurehayama member around Joyama area.

#### 5. Toge-chaya gravel, sand and mud alternation member.

This member was found in the Kurehayama tunnel of the Hokuriku Line. Distribution: The member is distributed in the west side of the hills but most of them are overlain by the Kurehayama member, then the outcrops of the member are few. Cutting of the Prefectural Road, cutting of the Kureha Tunnel at Nishikanaya. Stratigraphy: The member overlies the Kurehayama member and it underlies the Nishikanaya member. Rock materials: The member consists of gravel bed, peat bed, clay bed and sand and mud alternation at ascending order. Lower gravel bed consists of cobble size gravel, matrix is poor, its thickness is 10m on the Kurehayama Tunnel, but matrix is rich near the surface for weathering. Peat is 2m in thickness and consists of woody material. Rich floral remains have been found in the peat. Clay bed: It consists of very fine clay, and its thickness is 3–4m. That colour is blue in the fresh surface but it changes into grey green in air at once. There are rich floral remains in the clay and peat bed. Sand and mud alternation: Mud part changes to clay in the southern area from the national road. Many floral remains and wood stumps were found from this mud part. Sand part consists of coarse sand and rock fragments. Unit of alternation is about 30cm in thickness.

At the Kurehayama Tunnel (Hokuriku Line)

*Picea jezoensis*

*Tsuga diversifolia*

*Pinus koraiensis*

*Thuja standeshii*

Geology of the Kurehayama Hills

*Chamaecyparis pisifera*

*Prunus maximowiczii*

*Phellodendron amurense*

Bus stop of Toge-chaya

*Pinus jezoensis*

*Tsuga diversifolia*

*Abies homolepis*

*A. veitchii*

*Larix* sp.

*Pinus pentaphylla*

*P. koraiensis*

*Betula ermani*

Upper part of Furusawa

*Picea jezoensis*

*Tsuga diversifolia*

*Abies homolepis*

*A. veitchii*

*Pinus pentaphylla*

*P. koraiensis*

*Corylus heterophylla*

*C. sieboldiana*

*Alnus hirsuta*

*Fagus crenata*

Lower part of Furusawa

*Tsuga diversifolia*

*Abies homolepis*

*A. veitchii*

*Pinus pentaphylla*

*P. koraiensis*

*Cryptomeria japonica*

*Pterocarya rhoifolia*

*Juglans mandshurica*

*Carpinus cordata*  
*Ostrya japonica*  
*Corylus heterophylla*  
*C. sieboldiana*  
*Betula ermani*  
*Alnus hirsuta*  
*A. maximowiczii*

*Fagus crenata*  
*Quercus serrata*  
*Prunus domarium*  
*Phellodendron amurense*  
*Acer ruifinerve*

*Vitis coignetiae*  
*Tilia japonica*  
*Cratageus cuneata*  
*Actinidia polygama*  
*Stewartia pseudo-camellia*

*Cornus kousa*  
*C. contriversa*  
*Enkiantus campanulatus*  
*Viburnum sieboldii*  
*V. furcatum*

*Potamogeton distinctus*

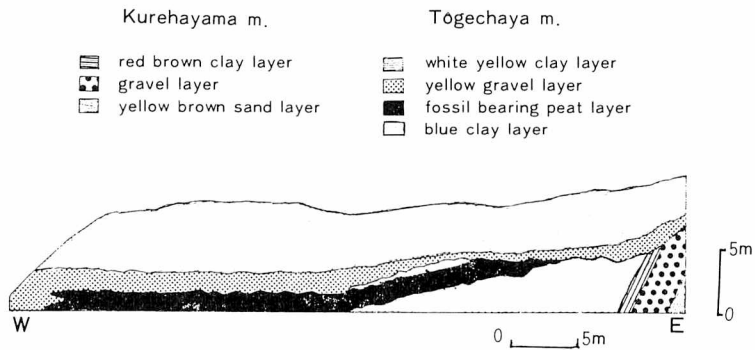


Fig. 2. Outcrop at Togechaya Bus Stop



6. Kitadai sand member

Type locality: Outcrop behind the Kitadai Primary School, Toyama city. Distribution: The north end of the Kureha tableland, and on the Kurehayama Hills of the tunnel of the Hokuriku Line. Rock materials: This member consists of massive coarse andesitic sand with pumice whose size is rice grain in the lower part. But there are many cross bedding lamina with granule in the upper part.

7. Nishikanaya sand member

Name of this member is changed from the former Kureha pyroclastic member (FUJII and SAKAMOTO 1961), because this member is not pure pyroclastic one. Type locality: A cliff near the Kureha Boys House for Nature Study. Stratigraphy: The member overlies the Toge-chaya member with conformity, and the bed is contemporaneous heterotrophic relation with the Kitadai sand member. The member overlies Neogene Tertiary group at cliffs of Tomosaka and the Hokuriku Highway. And it is covered by the Tomosaka gravel bed at Tomosaka. Distribution: The member is distributed around the west part of the Kurehayama Hills. The most thick part is the outcrop at a cliff of the Hokuriku Highway. Rock materials: The member consists of andesitic sand and scoria, and is intercalated by "azuki" coloured compact fine tuff layers with 1 – 5 cm thick. Sometimes granule of granite, chert and so on are found in this member.

8. Tomosaka gravel member

Type locality: A cliff of Tomosaka and a cutting of the Hokuriku Highway. Stratigraphy: The member overlies the Nishikanaya member and Neogene Tertiary group unconformably at Tomosaka. But this member is contemporaneous heterotrophic relation with Nishikanaya member and whose outcrop is seen at the cutting of the Hokuriku Highway. Rock materials: This member consists of gravels of 3 – 30cm in size. Various kinds of gravel are granite, quartz porphyry, andesite and so on, most gravel of the upper part are andesitic one. There are able to see lamina by gravel arrangement. Matrix is andesitic sand as same as the Kitadai member. The flat plain at Tomosaka may be erosional surface.

At the upper part of the south side cliff of the Hokuriku Highway

*Tsuga diversifolia*  
*Pinus koraiensis*  
*Cryptomeria japonica*  
*Thuja standishii*  
*Chamaecyparis pisifera*

9. Sakainoshin alluvial fan gravel member.

Type locality: Sakainoshin, Toyama-shi. There are few outcrops for geological surveying of this member. End of this member is covered by alluvial deposits of the Imizu plain.

10. Kurehayama fault

Kurehayama fault was described by T. TSUJIMURA (1926) at first. He had pointed out a straight cliff of the hills at the east side, and some kern butts and kern cols at An'yobo as proofs of fault. W. ICHIKAWA (1932) had described block movement of the Kurehayama Hills. S. FUJII, and T. SAKAMOTO could not find outcrop of fault along the east cliff and they stressed river erosion along the east cliff.

We can not find a fault in the cross section of the seismic analysis (TATEISHI 1950). But We can find Tertiary sediments in 30m deep bore hole at the campus of Toyama University. And we cannot find Tertiary sediments in 100m deep bore holes of Toyama city at the east of the Jinzu river. These events show us that Kurehayama fault may be step and parallel faults to the east side of Kurehayama Hills.

Neogene Tertiary group of the Kurehayama Hills takes part of the west wing of the folding. Block movement of the hills has continued along the fault during Quaternary which is described later. So active Kurehayama fault may exist.

11. Tomosaka fault

A synclinal structure is able to see at the cliff of Tomosaka, but there is a big stratigraphical difference between the west wing and the east wing of the syncline. Then an active Tomosaka fault has cut the Kurehayama member between both wings, although outcrop of the fault is unable to confirm yet.

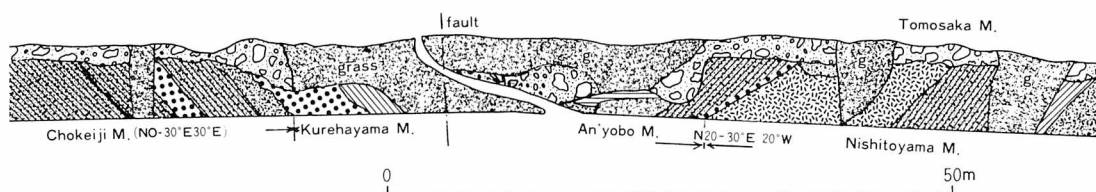


Fig. 3. Cutting at Tomosaka

### III Discussion

1. Correlation and age of each member

a. Nishitoyama sandstone member

## Geology of the Kurehayama Hills

A few mollusks are found in the member such as *Natica* sp., *Limopsis* sp. and *Turritella* sp., *Turritella* sp. is perhaps *Turritella saishuensis*.

### b. An'yobo sand and mud alternation member

Recently some marine mollusks were found in this member, such as *Patinopecten kurosawaensis*, *P. yessoensis*, *Macoma calcarea* and *Panope* sp. etc. These fossil mollusks are used to find in the Omma formation of the Pliocene age. Some mollusks which lived in mud such as *Yoldia* sp. *Megayoldia thraciaeformis gratioza*, *Lunatia* sp. are found in the cliff behind the Museum of Historical Materials at An'yobo. This member may be correlated to the upper part of the Omma formation.

There are no fossil evidences in Chokeiji member.

### c. Kurehayama gravel member

Also we have no fossil evidences of this member in this area. But some floral remains have been found at Hokogi, Fuchumachi in this member, such as *Salix* sp. *Magnolia kobus*, *M. obovata*, *Paliurus nipponicus*, *Amelopsis brevipedunculata*, *Sapium sebiferum* var. *Trapa mammilifera*, *T. maximowiczii*, *Styrax japonica*, *Fraxinus* sp. *Potamogeton* sp. Sedimentary environment of this member is an alluvium fan near seashore according to these floral remains and sedimentary facies. And this member correlates to the upper part of the Hanyu formation of the west part of Toyama basin and the upper part of Osaka group (FUJII and ONOGI 1967).

### d. Toge-chaya gravel, sand and mud alternation member

Many subalpine type floral remains have been found from this member such as *Tsuga diversifolia*, *Picea jezoensis* and *Pinus koraiensis*. Their remains show that the temperature of this age was 7°C colder than the present one in mean temperature. This cold age may be correlated to Mindel Glacial age according to the sedimentary succession and the floral remains.

### e. Kitadai sand, Nishikanaya sand member

These members have formed the surface of Kureha tableland. Such floral remains as *Juglans mandshurica*, *Fagus crenata*, *Sapium sebiferum*, *Sapindus mukurosi*, *Trapa macropoda*, *T. maximowiczii*, *Styrax japonica*, *Sciadopitys vaticillata* have been found from the Hinomiya member at the Imizu Hills. These members are correlated to the Hinomiya member judging by the heights of topographical surface and geological succession. Then these members are correlated to Riss/ Würm interglacial age according to sedimentary succession and floral remains. Upper part of Nishikanaya member bearing subalpine flora may be correlated to Würm Glacial age.

### f. Sakainoshin alluvium fan gravel member.

This fan is covered by alluvium deposits. Age of such alluvium fan is correlated to Shitadan age (Tachikawa age), Würm glacial age.

2. Development of the Kurehayama Hills

- a. Facies of the Kurehayama member are those of alluvium fan near seashore. And these gravels are brought from southern place by river, judging from imbrication of gravel deposit, rock species of gravel and recent land form. There was no hills in this area before these gravel were brought here.
- b. Sakainoshin alluvium fan is located between the Kurehayama Hills and the Imizu Hills. Then this alluvium fan formed after forming of the Kurehayama Hills.
- c. Toge-chaya member is distributed only the west side of the Kurehayama Hills and they have non marine mollusk *Cristaria* sp. and many floral remains in the mud bed. These events show that these deposits are one of lake or swamp. That is, the south and central part of the hills already became high to form lake basin in this age. But one part of Toge-chaya member inclined  $30^\circ$  to west at Toge-chaya. So this event shows the Kurehayama Hills also moved after the deposition of the Toge-chaya member.
- d. After deposition of the Kitadai member, the Kurehayama Hills also moved. Because the Kitadai member is inclined  $30^\circ$  on the Kurehayama Tunnel, although it distributes in horizontal dip at other part.

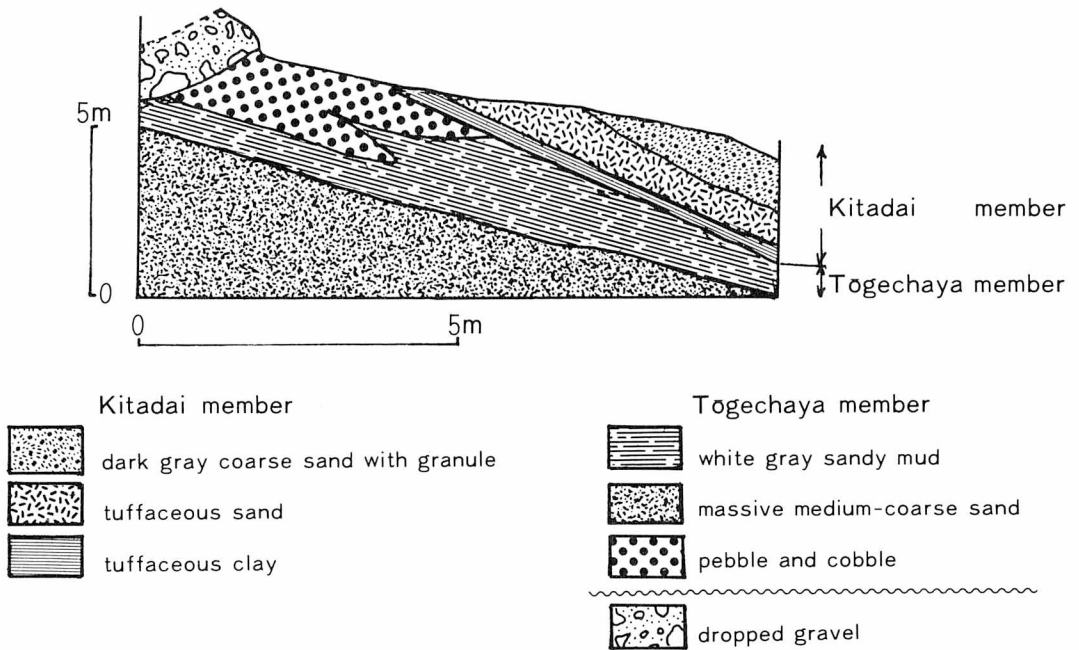


Fig. 4. Sketch of outcrop on Hokuriku Line Tunnel

## Geology of the Kurehayama Hills

- e. Of course, after deposition of the Tomosaka member, the Kurehayama Hills also rose.
- f. Kurehayama fault are also moved every times through Quaternary age. Tomosaka fault moved before deposition of the Tomosaka member. This outcrop is able to see at Tomosaka cliff. In this cliff, synclinal structure is apparent. This structure is formed between after deposition of Kurehayama member and before deposition of Tomosaka member.

Development of the Kurehayama Hills is summarized as follows;

There was no hills when the Kurehayama member was deposited. After deposition of the Kurehayama member, this area became high. The south and central part of the hills became high to form a lake during deposition of the Toge-chaya member. The climate of this age is cold according to the floral remains, and it may be correlated to Mindel Glacial age.

Lake or swamp were formed during the age of Toge-chaya, Kitadai and Nishikanaya member deposition, according to fossil fresh water mollusks and floral remains. Then, its age is correlated to the Riss Würm Interglacial age. After deposition of Kitadai sand, the Kurehayama Hills raised again and rising movement extends to the northern part. Most of the Kurehayama Hills geomorphologically were formed before deposition of the Sakainoshin (alluvial fan gravel) member. After deposition of Sakainoshin member, the river which brought a lot of deposits changes its trend from the west side to the east side of the hills. Kurehayama fault might be moved every time when the Kurehayama Hills rose.

Tomosaka fault cuts the Kurehayama member and it is covered by Tomosaka member. Also synclinal structure was formed with this fault.

### References

- FUJII, S.(1958) Development of the Kurehayama Hills. *Nature and Society* **21**, 9 – 11
- FUJII, S. and SAKAMOTO T. (1961) Geology of the Kurehayama Heights. *Study for Cenozoic Age*, **32**, 797 – 803
- FUJII, S and ONOGI K. (1967) Quaternary Geology around Isurugimachi the west part of Toyama Pref. *Memorial Volume of Prof. Y. Sasa*, 355 – 363
- FUJII, S., MATSUMOTO N., YAMAMOTO O. and WATANABE H. (1972) The Floral Remains Showing the Cold Climate Occured From Kurehayama, Toyama Pref., Central Japan. *Jour. Geol. Soc. Japan* **78**, 513 – 514 with 1 plate
- FUJII, S., MATSUMOTO N., YAMAMOTO O., TSUJI H., IMAI R. and NAKAMURA Y. (1974) Floral Remains Showing the Cold Climate Occured from Kurehayama (Furusawa, and Sugitani), Toyama Pref., Central Japan. *Preprint of the Annual Meeting of Japanese*

Quaternary Research (1974), 6-7

ICHIKAWA, W.(1932) Geomorphological Study of the Kurehayama Hills and its Western Hills Chikyū 17, 206-215

IMAMURA, S.(1932) Tertiary Yatsuo Formation, Specially Distribution of Foraminifera Bearing Rocks. Jour. Geol. Soc. Japan. 39, 310-312

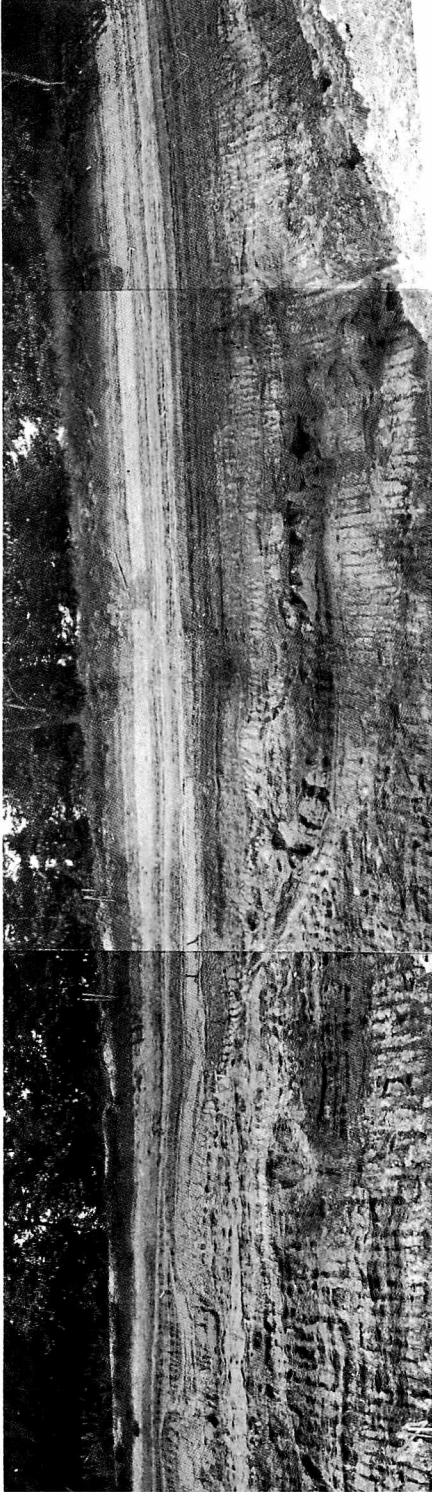
TATEISHI, T.(1950) Report on Seismic Prospecting near West Toyama Bull. of Geological Survey of Japan 1, 78-80

TSUJIMURA, T. (1926) One Type of Fault Scarp Around the Northern Part of Hida Range. Geographical Review of Japan, 8, 679-695

Most of these papers are written in Japanese with English abstract.

**Plate I**

Outcrop of Toge-chaya member at the west side of Kureha Tunnel (Arisawa Line). Many subalpine type floral remains are occurred.



**Plate II**

Floral remains of Toge-chaya member from Furusawa

- |                               |           |
|-------------------------------|-----------|
| A: <i>Pinus koraiensis</i>    | seeds     |
| B: <i>Alnus hirsuta</i>       | corn      |
| C: <i>Tsuga diversifolia</i>  | cones     |
| D: <i>Fagus crenata</i>       | acorn-cup |
| E: <i>Criptmeria japonica</i> | leaf      |
| F: <i>Fagus crenata</i>       | leaf      |



**A**



**B**



**E**



**C**



**F**



**D**



**Plate III**

Floral remains of upper part of Toge-chaya member from Furusawa

- |                              |       |
|------------------------------|-------|
| A: <i>Pinus koraiensis</i>   | seed  |
| B: <i>Tsuga diversifolia</i> | cones |
| C: <i>Picea jezoensis</i>    | cones |
| D: <i>Pinus pentaphylla</i>  | cones |
| E: <i>Tsuga diversifolia</i> | leaf  |
| F: <i>Pinus pentaphylla</i>  | leaf  |

**A**



**E**



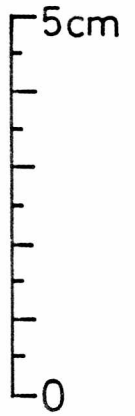
**B**



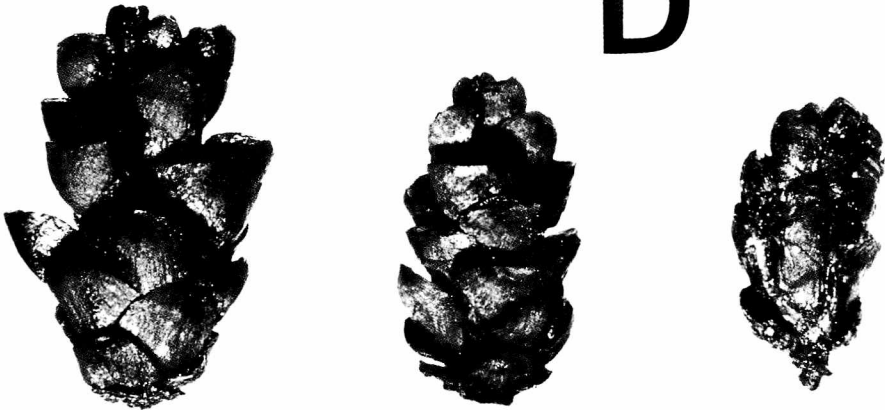
**F**



**C**



**D**

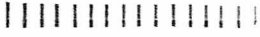


**Plate IV**

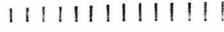
Floral remains of Toge-chaya member from Furusawa

- |                                    |                |
|------------------------------------|----------------|
| A: <i>Corylus sieboldiana</i>      | nut            |
| B: <i>Abies homolepis</i>          | leaf and scale |
| C: <i>Corylus heterophylla</i>     | seed           |
| D: <i>Abies veitchii</i>           | scale          |
| E: <i>Quercus serrata</i>          | nut            |
| F: <i>Enkianthus campanulatus</i>  | capsule        |
| G: <i>Juglans mandshurica</i>      | seed           |
| H: <i>Thuja standishii</i>         | leaf           |
| I: <i>Crataegus cuneata</i>        | capsule        |
| J: <i>Stewartia pseudocamellia</i> | capsule        |

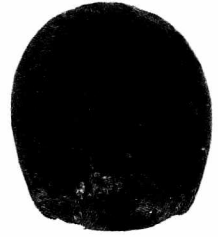
**A**



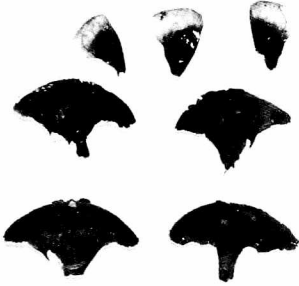
**B**



**C**



**D**



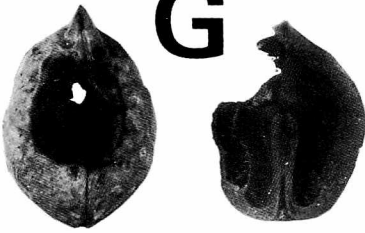
**E**



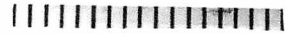
**F**



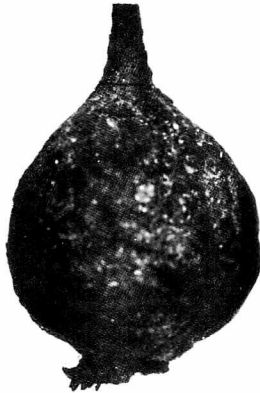
**G**



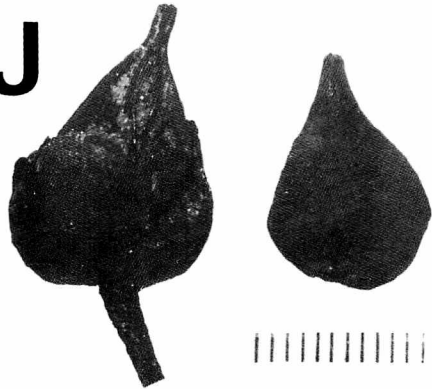
**H**



**I**



**J**



# Geological Map of Kurehayama Hills

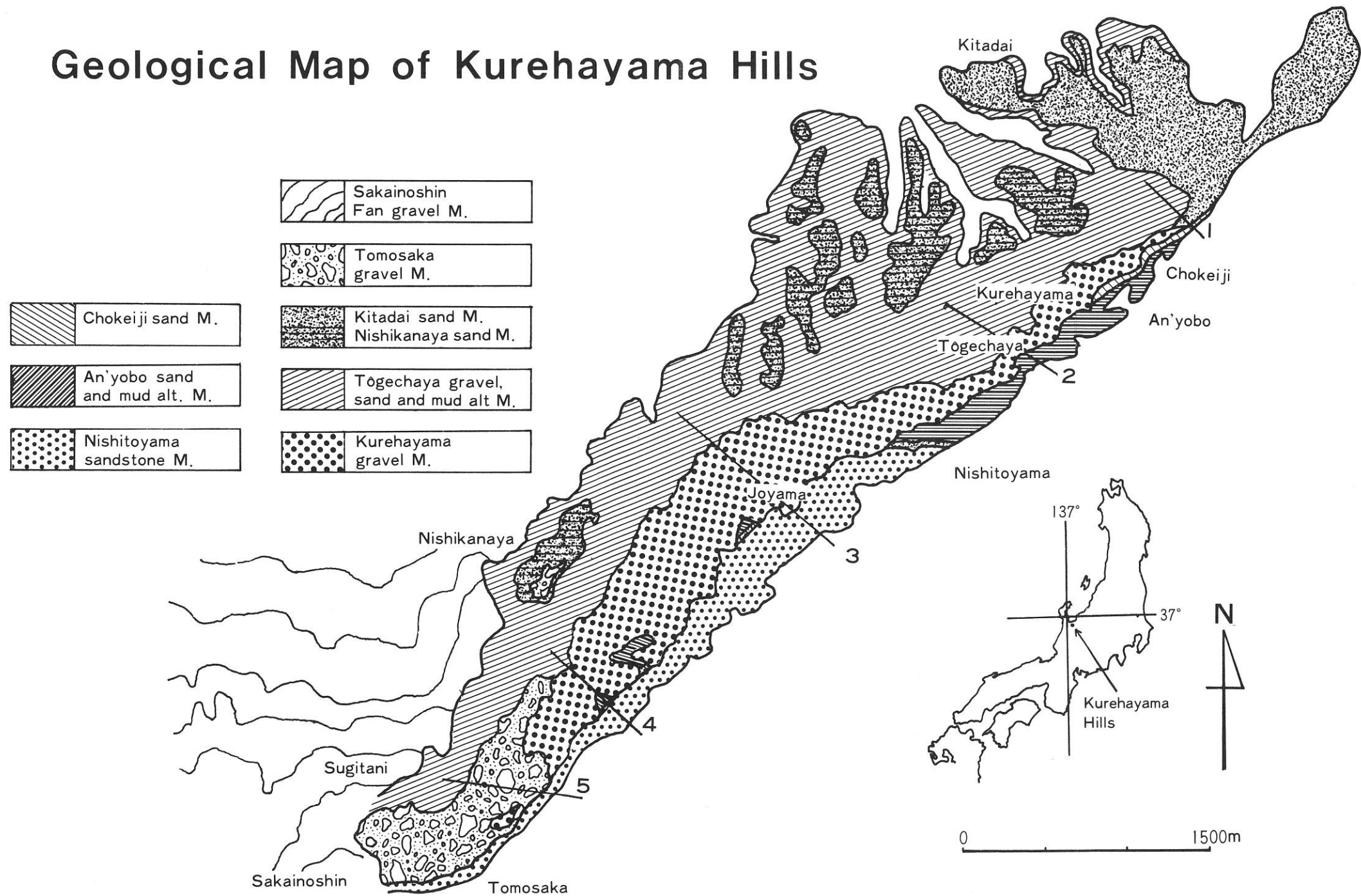


Fig. 1a. Geological Map of Kurehayama Hills