

***Classification and Correlation of Shinshu Loam
in the South Shinshu Tephrogenetic Region,
Central Japan***

By Kunio KOBAYASHI and Hideki SHIMIZU

Department of Geology, Faculty of Liberal Arts and Science, Shinshu University

(Received Nov. 30, 1965)

Contents

| | |
|--------------------------------------|----------------------------------|
| 1 South Shinshu Tephrogenetic Region | 4 Associated Flora |
| 2 Redefinition of Shinshu Loam unit | 4-1 General Remarks |
| 2-1 Younger Loam | 4-2 Notes on Plant beds (1)-(10) |
| 2-2 Middle Loam | 5 Summary and Acknowledgements |
| 2-3 Older Loam | References |
| 3 Terrace Classification | Explanation of Plates (2 Pls.) |

1 South Shinshu Tephrogenetic Region

A term is newly proposed to indicate a region within which essentially a similar stratigraphic succession of tephra deposits is available, even though the materials were not supplied from a single volcanic source. This conception may also be convenient for many purposes to decipher stratigraphic relation between two or more tephrogenetic regions, because in Japan tephra deposits are so much in amount that in the areas where tephra were supplied from many volcanic sources, are raised intricate problems. So, the authors are to propose a new term "Tephrogenetic region" which is defined as "a region in which essentially a similar tephra succession is recognized over a certain areal extent and its succession can be set off from those of other areas".

From Shinshu district have been recognized several such tephrogenetic regions which originate from activities of different source volcanoes (KOBAYASHI, 1962).

Classification of the so-called "Shinshu Loam" which actually should be called "Pleistocene tephra in Shinshu district" was first in 1960 classified by KOBAYASHI (1960, 1961). At that time, he concerned a type of tephra succession which is well exposed at the type location near Osakada in Shiojiri City at the southern extremity of the Matsumoto basin. From exposures at the road-cut near Osakada, three tephra units were established, from younger to older, as the Hata, Osakada and Nishibayashi Loam units. Each stratigraphic unit,

however, shows a marked increase of thickness toward the south, accordingly the total thickness of them all measures often as thick as 10m. or more in the middle part of the Ina valley, suggesting that the main source is attributed to Ontake volcanoes due west of the Ina valley. Thus it has been confirmed that there is a tephrogenetic region to be called the "South Shinshu tephrogenetic region" in which tephra deposits have been supplied mainly from Ontake volcanoes and covering about $0.7 \times 10^4 \text{km}^2$ in areal extent. It embraces several basins, valleys, and also many lofty mountains of Central Japan, though upon precipitous slopes tephra covers are hardly recognized.

Recent studies of river terraces, associated air-laid tephra covers, and water-laid tephra layers along with studies on the sequence of activity of Ontake volcanoes, which have been undertaken by T. KOBAYASHI of Hokkaido University, have disclosed the relationship of tephra falls distant from the source, to such nearby products of volcanoes, as lava-flows, pyroclastic flows and falls, and so forth. Moreover that, not only such stratigraphic confirmations but also many plant beds associated with these tephra, provide priceless clues to elaborate a chronological chart of the Quaternary history of the South Shinshu tephrogenetic region (Fig. 1; Table 2).

2 Redefinition of Shinshu Loam

Type location: In the Ina valley, three stratigraphic units of tephra are named, from younger to older, as the Younger, Middle, and Older Loam units. A big cliff newly cut at the Junior High School of Ina-Higashi (Ina-East) is employed as the type location of the Shinshu Loam formations in the Ina valley (Fig. 2; Colored photo Pl. 1). As for Older Loam, there is no exposition at this type locality. However, in July of 1962, a new cliff was made by construction on the Kojin'yama hill south of the town of Tatsuno in the northern part of the Ina valley (Fig. 2; Photo, Pl. 2). This newly exposed section is the type location of the Older Loam unit, providing crucial informations about the lithological succession in contrast to our former meagre knowledges.

2-1 Younger Loam unit

Lithology: The top member of the Shinshu Loam formations is the Younger Loam unit situated immediately below top soil. It is 4 to 6 m. in thickness around the town of Ina, and embeds two distinct pumice beds respectively called the pumice bed IV (Pm-IV) and the pumice bed V (Pm-V). The lower demarcation of this Loam unit is usually placed about 20cm. below the lower limit of the Pm-IV.

The materials are, as a whole, weathered brown ash, and under wet condition less sticky than those of Middle Loam. The Pm-IV is tinted in a marked

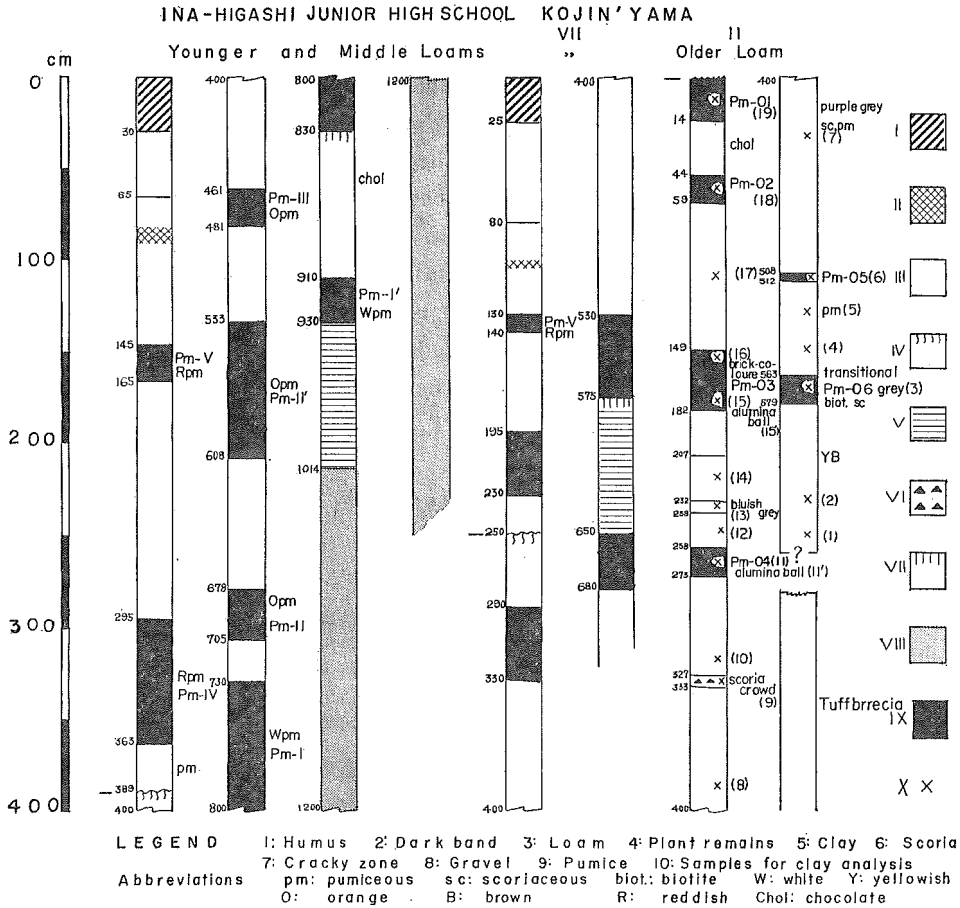


Fig. 2 Type section of Younger and Middle Loams at Ina-Higashi Junior High School and Kojin'yama-VII, and that of Older Loam on Kojin'yama hill. Number in parenthesis indicates sample for clay analysis.

reddish brown (2.5 YR 5/6 on the Munsell scale) and consists of coarse-grained pumices intermingled with scoriae. It is considerably wide in distribution and traceable toward the east as far as 80km. in distance, to Nakayama 25km. west of Kofu in Yamanashi prefecture. With its distinguished tint, it proves to be a valid long-distance key bed. It has a maximum thickness of about 60 cm. in the environs north of the town of Ina (Fig. 3).

The pumice bed Pm-V usually is embedded approximately, within the middle part of Younger Loam, but this is not thick, often marked by sparing reddish brown pumice grains and scoriae.

Buried soil: Though a faint sign of dark-colored band or layer or buried soil is present within Hata Loam or the equivalent of Younger Loam (KOBAYASHI, 1960, 1961), this sign may not have resulted only in terms of interruption of ash

showering. The weathering process indicated by buried soil would not always be concerned with a restricted time-interval when ash showering stopped for a relatively long period, because a stratigraphic unit of tephra would normally comprise more or less numerous hiatuses or diastems. Our attentions are called to the statement by MORRISON and FRYE (1965) who realized that the weathering optima were assumed to have been caused by some other kind of climatic factor.

2-2 Middle Loam

Relation to other Loam units: As discussed, with respect to the depositional feature of Shinshu Loam in the Matsumoto basin (KOBAYASHI, 1960, 1961), an unconformable relation is recognized below the pumice bed Pm-I of Osakada Loam. In this region, however, no such sign is indicated below the pumice bed Pm-I, accordingly the lower demarcation of Middle Loam should be replaced to a lower horizon than the Pm-I, because about one meter of Loamy material is present conformably below the Pm-I.

As for the upper limit of this unit, an uneven surface demonstrates an occurrence of time-interval below Younger Loam (KOBAYASHI and SHIMIZU, 1962, p. 23-24). SAKAI (1963) illustrated a relative dominance of magnetite in heavy mineral composition of the weathered zone at the top of this unit. The fact is properly considered as having resulted from the high stability of magnetite against weathering.

The Middle Loam unit 5m. thick in the middle part of the Ina valley, is extremely pumiceous and usually comprises four or five marked air-laid pumice beds which at many exposures are, from lower to upper, white, yellowish orange, and brown in colour, and being designated as "Pm-I'", "Pm-I", "Pm-II", "Pm-II'", and "Pm-III". Exceptionally, the Pm-III of water-deposition is white in colour.

Among these, the Pm-I is thickest, and in distribution widest, covering the areal extent of about $1.5 \times 10^4 \text{ km}^2$. The total volume of pumice grains would have attained to more than $3 \times 10^9 \text{ m}^3$. In the environs of Komagane 10 km. south of the town of Ina, it attains a maximum thickness of more than 2m. (KOBAYASHI et al., 1965 a, b, c, and unpublished). The pumice grain is made of white or yellowish fibrous glass when it is unaltered, whereas it has been highly clayed into hydrated halloysite perhaps influenced by ground water (KOBAYASHI and SHIMIZU, 1962). With its characteristic appearances and its distinguished thickness which attains more than 50cm. even at a distance of 100 km. from the source volcanoes, the pumice bed is easily discriminated from other pumice beds.

The pumice grain contains extremely less amount of colored minerals.

Heavy mineral composition indicates a high excess of dark green hornblende and magnetite, and a few amount of augite and hypersthene together with a very few amount of biotite. Peculiarly, a remarkable occurrence of zircon characterizes the composition, sometimes reaching up to 10% or more of the total numbers of heavy minerals. Other parts between pumice beds of Middle Loam are composed of fine materials in greyish brown and more sticky as compared with Younger Loam.

Stratigraphic position: Middle Loam of air-deposition conformably lies upon the broad Rokudohara terrace and upon the Oizumi terrace respectively on the east and west of the Tenryu river. For certain reasons, the term Oizumi terrace formerly used in our paper (KOBAYASHI and SHIMIZU, 1962) is to be employed in this paper as an equivalent of the Rokudohara terrace (See page 44 and Table 2 of this paper).

As was discussed in our papers (KOBAYASHI, 1965 a, b; KOBAYASHI et al., 1965; SHIMIZU et al., 1965 a, b), the Pm-I has been confirmed to be traceable far into Shimosueyoshi Loam of the South Kanto tephrogenetic region. This opinion has received some rejections based upon inferences seemingly not authorized by facts. For instance, it has been orally alleged that Pm-I stratigraphically be placed at higher position than we have expected, because the Pm-I looks younger in the mode of occurrence. But we cannot do better than to rely on records in nature.

2-3 Older Loam

General remarks: The Kojin' yama hill is about 50m. higher above the stream floor of the Tenryu river, and its basement consists of decayed gravel and boulder of intensively weathered andesite, showing in parts an appearance of volcanic mudflows. This is undoubtedly assigned to a part of the Pliocene Enrei formation. Upon this basement is a thick air-laid tephra which is dismembered into three units of Shinshu Loam. Formerly, Older Loam was supposed to embed pumice beds, because discontinuous pumice layers named as "Pm-O" have been known within the Tagiri or Takao gravel which stratigraphically is lower than the newly defined Oizumi gravel (Table 1).

Inasmuch as our observations have been made, Older Loam at the type locality (Fig. 2) seems to be unconformably covered by the Pm-I, so that it is inferred that between the former and the Middle Loam unit is placed a considerably big stratigraphic break which formerly was expected to correspond with the period when the Oizumi gravel was deposited. But a section exposed at a cliff near Yaotome (Eight girls) on the west of the Tenryu river shows an intercalation of Loamy silts within the Oizumi gravel, possibly raising an opposition against our former opinion (Fig. 3c-11).

Lithology: Older Loam is dark-brownish and much cracky with vertical joints perhaps due to an intensive weathering (Pl. 2). In lithology, it is much pumiceous and scoriaceous, and intercalates six remarkable pumice beds and a few thin pumice lentils at the type locality. These pumice beds are named, from upper to lower, as "Pm-01", "Pm-02", "Pm-03", "Pm-04", "Pm-05", and "Pm-06". Within crevices of both pumice beds, the Pm-03 and Pm-04 are contained white flat-shaped balls - the so-called "Alumina ball" from 2 to 3cm. in diameter. Clay mineralogical investigation (KURAHAYASHI, unpublished) suggests that Older Loam would date back to older ages than the Shimosueyoshi stage or the Riss-Würm Interglacial. Air-laid pumices of Older Loam are intensively decomposed, prohibiting identification of primary composition of heavy minerals. Usually they are simply characterized by excess of magnetite which is stable against weathering. Characteristic lithology of some pumice layer of air-deposition sometimes is quite different from that of the same pumice layer of water-deposition.

3 Terrace Classification

Since the publication of our previous paper, have been clarified an outstanding feature of long-profiles of terraces along tributary streams of the Tenryu river, and also a few additional facts. In another paper, we will discuss that a kind of topographic inversion commonly occurs along tributary streams. For instance, the Mikoshiba terrace which is lower than the Oizumi terrace along the lower reach of a tributary stream increases its height toward the upstream, with the result that the Mikoshiba terrace superposes the upper part of the Oizumi terrace. This sort of crossing of long-profile of terraces along tributary streams well have been known, based upon tephrochronologic study conducted throughout the valley of Ina (KOBAYASHI and SHIMIZU, unpublished).

In the present paper, some revision of nomenclature of the terraces in the Ina valley is to be made, as illustrated in (Table 1 and 2).

The name "Tera" terrace used in our former paper (KOBAYASHI and SHIMIZU, 1962, p.21 and p.32-33) is treated as a correlative name of the "Takao" terrace in this paper, and the newly defined name "Oizumi" terrace is to be used as an equivalent of the Rokudohara terrace on the east of the Tenryu river. The terrace which formerly was named as the "Oizumi" terrace is to be called the "Transitional" terrace whose abbreviation is indicated as "OM" implying that it stands between the Oizumi terrace (newly defined) and the Mikoshiba terrace. Beside these, the Mikoshiba terrace is to be subdivided into two groups of terrace, i. e. the Mikoshiba terrace 1 and 2.

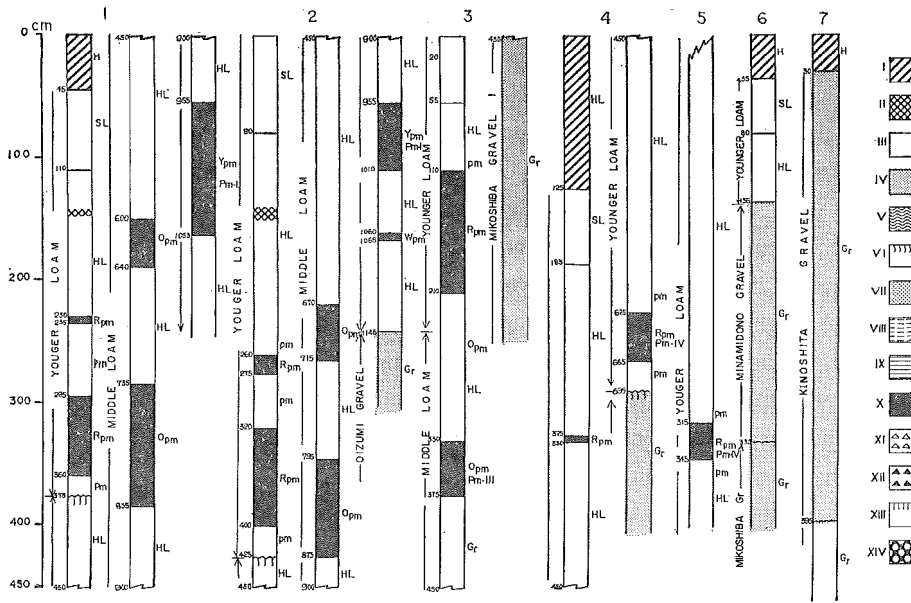


Fig. 3-a Columnar sections of Shinshu Loam

Legend, See Fig. 2, V:peat, VIII:silt, XI:tuff-breccia, XIV:gravel veneer. Abbreviations, H:Humus, SL:Soft Loam, HL:Hard Loam, Cl:Clay, St:Silt, Sd:Sand, Gr:Gravel, TB:Tuff breccia, GV:Gravel veneer, pm:pumiceous, sc:scoriaceous, sdy:sandy, L:Loamy, W:white, O:orange, Y:yellow. B: brown, R:red, D:dark, 1. Tabata-II (OZ), 2. Misono-I (OZ: type section below the OZ terrace), 3. Misono-IV-Residence section-I (type section below the OM terrace), 4. Misono-II- Residential section-II (MK1), 5. Ina Elementary School (MK1), 6. Misono-IV (MD), 7. Misono- V (KS)

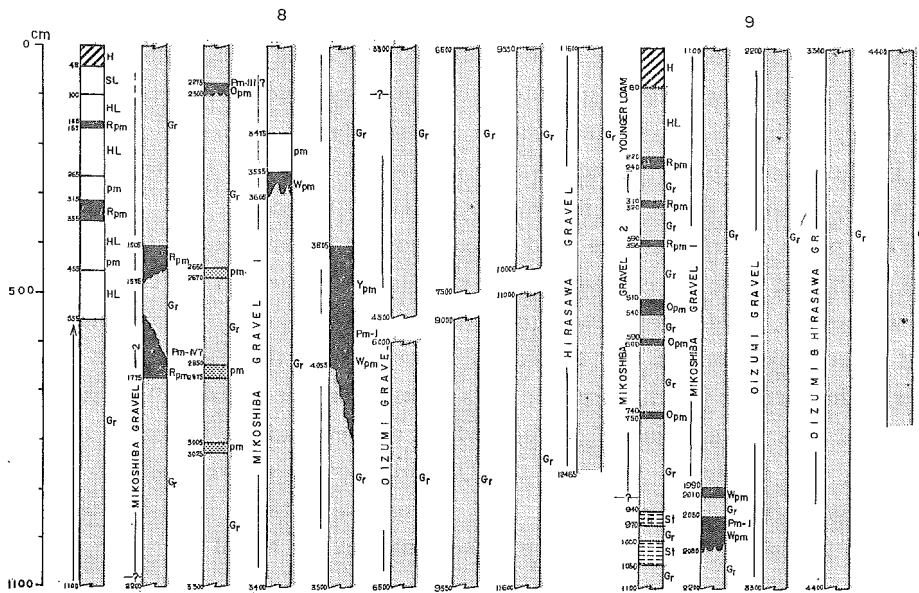


Fig. 3-b Columnar sections of Shinshu Loam

8 Yochi-II (MK), 9 Nakaozawa II (MK2), Mikoshiba gravel 2 unconformably lies upon the Mikoshiba gravel 1.

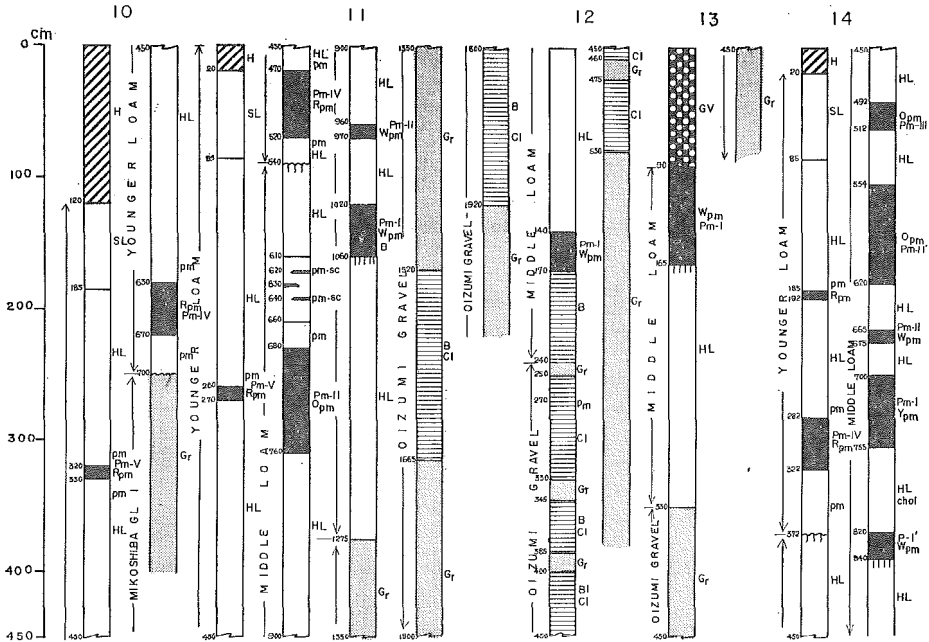


Fig. 3-c Columnar sections of Shinshu Loam

10. Hachiman shrine in Ina (MK1), 11. Yaotome 3 km. northwest of the town of Matsushima, Ina (OZ, within the Oizumi gravel are two water-deposited Loamy beds which raises a problem if there is any big time-break between Middle and Older Loams) 12. Nagaoka (OZ), 13. Mikoshiha (KS, gravel veneer overlies the water-deposited Middle Loam, 14. Minamidono Hachiman shrine in Minowa-mura (OZ)

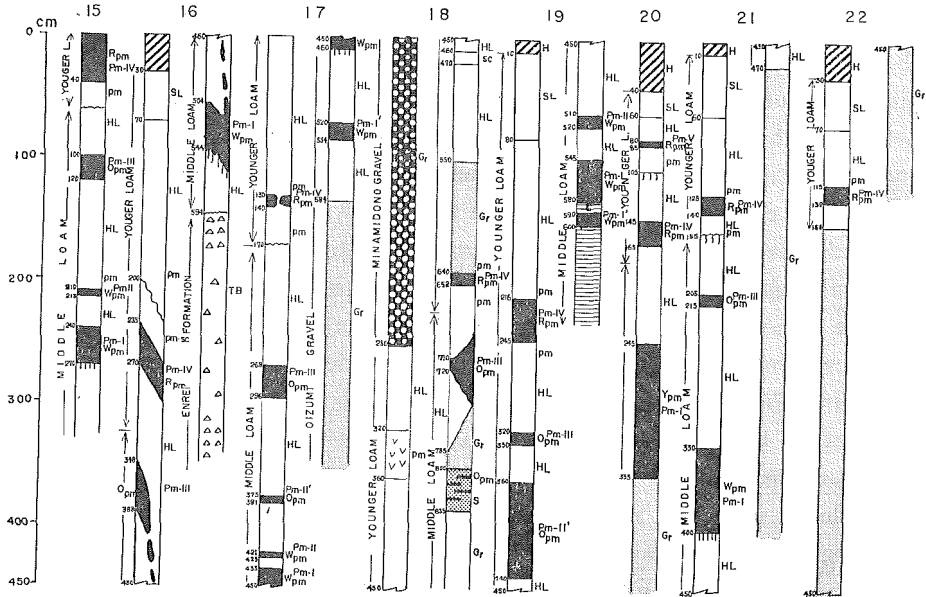


Fig. 3-d Columnar sections of Shinshu Loam

15: Godo-II (TK), 16. Kojin'yama-VI (near to Kojin'yama-VII illustrated in Fig. 2), 17. Tatsuno-Shinmahi (OZ, the pumice bed Pm-IP' is thinner than the Pm-III), 18. Oide-IV (MD ?), 19. Nosoko-II (OZ), 20. Tomigata (OZ), 21. Hasemura-III (OZ), 22. Nyuyama-VI (MK1)

Table 1 Revised classification and nomenclature of river terraces in the Ina valley

| Tephra | Symbol | West Tenryu | East Tenryu |
|--------|--------|---------------------|------------------|
| | | Flood plain | Flood plain |
| | K S | Kinoshita terrace | Lowest terrace |
| Pm-V | MD | Minamidono terrace. | Minamidono ter. |
| Pm-IV | MK 2 | Mikoshiha terrace 2 | Mikoshiha ter. 2 |
| | MK 1 | " 1 | " 1 |
| Pm-III | OM | Transitional ter. | ? |
| Pm-II' | | | |
| Pm-II | | | |
| Pm-I | | | |
| Pm-I' | O Z | Oizumi terrace | Rokudohara ter. |
| | T K | Takao terrace | Tera terrace ? |
| Pm-0 | | | |

4 Associated Flora

4-1 General remarks

Fossil plant beds have been known from many localities over a wide area within and outside this tephrogenetic region. Many of these have direct connection with index tephra horizons, permitting confirmation of their tephrochronologic situations, otherwise drawing inference of their stratigraphic situations. An extensive survey of these flora now being carried by K. SUZUKI, will provides detailed composition of flora and their climatic implication.

Generally speaking, many evidences for deterioration have been detected within the period when Younger and Middle Loam were deposited. The cooler type of flora comprises some of such cool-temperate species as *Pinus koraiensis*, *Tsuga diversifolia*, *Picea maximoviczii* and a hydrophyte *Menyanthes trifoliata* etc., whereas the warmer type of flora usually comprises warm-temperate broad-leafed trees.

The floral sequence recognized from this tephrogenetic region indicates that through the period when Younger and Middle Loam were deposited, the climate was reduced, justifying that the period should naturally be referred to the Würm glacial phase of the Alpine glaciation. The fact has importance, for the period from the Shimosueyoshi Loam stage to the Tachikawa Loam

Table 2 Correlation and stratigraphy of Shinshu Loam (tephra), associated gravels, terraces and plant beds.

| GEOLOGE | T E P H R A | | FLUVIATILE GRAVEL | RIVER TERRACE | ASSOCIATED PLANT BEDS & CLIMATIC IMPLICATION | IDENTIFIER OF FOSSILS, AUTHOR |
|-----------------|-------------------------------|-------------------|--------------------|----------------------|--|---|
| | STRAT. UNIT | PUMICE | | | | |
| <i>Holocene</i> | <i>H u m u s</i> | | Flood plain | Kinoshita terrace | KS | ○ Karakemi peat bog YAMAGATA (1957) |
| M | Tachikawa ? Loam stage | Pm-V | Minamidono gravel | Minamidono ter. | MD | ● Totchu conifer beds 15,750±390 C-14 ys. YAMANOUCI, KOBAYASHI (1958) |
| | | | Mikoshiba gravel 2 | Mikoshiba terrace 2 | MK2 | ○ lignite from Kisogawa volcanic mudflows ca. 2,7,000C-14 ys. QUAT. RES. GROUP KISO VALLEY & KIGOSHI (1964) |
| R | Musashino ? Loam stage | Pm-IV | Mikoshiba gravel 1 | Mikoshiba terrace 1 | MK1 | |
| | | | | Transitional terrace | OM | ● Takigoshi plant beds KOKAWA, KOBAYASHI (1965b) ● Ono <i>Menyanthes</i> beds, Aiyoshi plant beds (>30,000 C-14 ys.) <i>Bison</i> from Hiraide SUZUKI (unpublished), KAMEI (unpublished) |
| U | Shimosueyoshi ? Loam stage | Pm-III Pm-II' | | | | |
| | | | Pm-II | | | |
| W | Shimosueyoshi ? Loam stage | Pm-I Pm-I' | | | | |
| | | | | Oizumi terrace | OZ | ○ Oshio peat beds, lignite from Yochi KAWACHI & KITAZAWA (unpublished) KOBAYASHI & SHIMIZU (unpublished) |
| R/W | Shimosueyoshi ? Loam stage | Pm-O1 | Oizumi gravel | Takao terrace | TK | ○ Kobuchizawa plant beds, Wakamiko-Shinmachi plant beds, Nyuyama, Yatsude SUZUKI (unpublished) |
| | | | | | | |
| S | Older Loam | -02 -03 -04 | Takao gravel | | | ○ exact stratigraphic position uncertain ● Kamikuroda peat beds NASU, MORI (unpublished) |
| | | | scoria | | | |
| M/R | | -05 -06 | | | | ○ Kuramoto-Yukawa broad-leaved tree beds SUZUKI (unpublished) |
| | | | | | | |

○ warmer than the present

● similar to the present

● cooler than the present

stage should cover roughly the entire time-length of the Würm glacial (KOBAYASHI, 1965 a, b).

An evidence for interglacial warmth has been known from the floral assemblage of Wakamiko-Shinmachi plant beds, whose location is on the western border of Yamanashi prefecture. Based upon the mode of occurrence of the Pm-I, it is doubtless to assign its age to the Riss-Würm Interglacial. According to SUZUKI's identification, another evidence for warmer climate is also found from the flora of the Kuramoto-Yukawa plant beds which exclusively consists of broad-leaved trees and being at the height of about 1,200m. a. s. l. The beds are overlain by groups of older lava flows whose top member is, according to T. KOBAYASHI, covered unconformably by the Pm-I, therefore the flora is very likely to represent an older interglacial warmth, possibly that of the Mindel-Riss Interglacial.

4-2 Notes on Plant beds

(1) Karakemi peat beds

Location: Aikawa 3 km. southeast of the town of Omachi City, in the northern part of the Matsumoto basin, N. Lat. $36^{\circ} 29.1'$; E. Long. $137^{\circ} 53.4'$; Alt. 960 m. a. s. l.

Stratigraphic position: Two peat bogs are developed in shallow basins formed upon the surface of an inclined Pliocene alternation of tuff and gravel. A larger one is called "Karakemi" (Desiccated marsh) peat bog which now is in a stage of high moor. The peat is 3 m. or more thick in the center of the moor, and contains at upper horizons abundant seeds of *Brasenia purpurea* and at lower horizons less amount of seeds of bog-bean (*Menyanthes trifoliata*), both of which now are often found in wild growth in this environs. The place is within another tephrogenetic region where tephra was supplied mainly from Tateyama volcanoes, but the development of peat undoubtedly dates from some time during Holocene time. According to YAMAGATA (1957) who once made a pollen analysis of the *Menyanthes* bed, the pollen flora consists mostly of broad-leaved trees such as *Alnus*, *Betula*, *Carpinus*, *Fagus*, and *Quercus*. A few conifers, mostly *Pinus*, and also a few pollens of other broad-leaved trees such as *Cypressaceae*, *Pterocarya*, *Ulmus*, *Salix*, and *Cryptomeria* are accompanied. The flora indicates a climate not dissimilar to that of the present days.

(2) Totchu conifer beds

Location: 1 km. east of Akashina north of Matsumoto. N. Lat. $36^{\circ}21'$; E. Long. $137^{\circ}49'$, Alt. : 600 m. a. s. l.

Absolute age: $15,750 \pm 390$ C-14 years B. P. (GaK-161 ; KIGOSHI et al., 1962; KOBAYASHI, 1958, 1965 a, b, c).

Stratigraphic position: A detailed explanation about this buried forest was

presented in a previous paper (KOBAYASHI, 1958, p. 55).

Climatic implication: The flora exclusively consists of conifers such as *Pinus koraiensis*, *Picea maximoviczii*, *P. yessoensis*, var. *hondoensis*, *Tsuga diversifolia* and *Abies Veitchii* and suggests the coldness during later part of the Würm glacial phase, because the present lower limit of the conifer zone is at the level of 1,500 m in Central Japan.

(3) Takigoshi plant beds

Location: Takigoshi on a tributary stream—the Otaki river branching from the Kiso river. N. Lat. 35°47.8': E. Long. 137°28.5'; Alt. 1,100 m. a. s. l.

Stratigraphic position: The Otaki river on which a small village or Takigoshi is located, flows eastward beside the southern base of Ontake volcanoes. The deposit with somewhat a lacustrine facies is exposed as the dissected fill of the former narrow valley excavated after the extrusion of the Kurakoshihara lava flows (the lava flow "M-6" of Koze, 1908). The deposit is an approximate equivalent of the Kiso-dani formations (QUATERNARY RESEARCH GROUP OF KISO VALLEY, and KIGOSHI, 1964) and yields plant remains from a horizon above the Pm-III.

Climatic implication: The floral composition was surveyed by K. KOKAWA and by his courtesy I had an opportunity to give accounts of this flora in the INQUA volume recently published (See page 380–381 of KOBAYASHI, 1965b). The flora consists of much amount of *Tsuga diversifolia*, accompanied by *Picea jezoensis* (*P. jezoensis* var. *hondoensis* ?), *Larix kaempferi*, and a few amount of *Abies Veitchii* and *A. homolepis*. Also a few broad-leaved trees such as *Alnus maximoviczii*, *Stewartia pseudocamellia* ?, *Corylopsis* sp. ?, *Acer* sp., and *Sambucus sieboldiana* are yielded. Such a feature of this flora is believed to indicate a cooler climate.

(4a) Ono Menyanthes beds (Ono-III)

Location: Western part of a small town of Ono, Tatsuno-cho, N. Lat. 36°2.4'; E. Long. 137°53.7'; Alt. : 830 m. a. s. l. (Fig. 4)

Stratigraphic position: A small basin near the valley-head of the Ono river, a tributary of the Tenryu river, seems to have once been under the standing water, because marshy deposits intercalating plant seams are in places exposed at little cliffs around the town. There, the water-laid pumice bed Pm-I is unconformably overlain by lignite bearing plant beds, within which are contained less weathered hard pumice grains that are identified with those of the Pm-III. Heavy mineral compositions of the pumice grains from both plant beds at Loc. Ono-III and Loc. Aiyoshi-II (on page 33 in our previous paper of 1962) are shown in Table 3.

Climatic implication: Peaty beds above and below the horizon of the Pm-III contain seeds of bog-bean (*Menyanthes trifoliata*) and often cones of *Picea*.

Table 3 Heavy mineral composition of pumice from Ono lake deposit (grain-size fraction 1/8~1/16 mm).

| Locality | hornb. | aug. | hypers. | mag. | others | H/T% |
|----------------|--------|------|---------|------|--------|------|
| Ono-IIIa-16 | 14.1 | 3.5 | 54.5 | 26.7 | 1.2 | 4.5 |
| Ono-IIIa-15 | 10.0 | 10.0 | 53.0 | 23.5 | 3.4 | 9.2 |
| Ono-IIIc-1 | 26.7 | 0.3 | 31.0 | 42.0 | — | 10.9 |
| Aiyoshi-II-240 | 5.9 | 8.2 | 75.2 | 7.8 | 3.1 | 24.2 |

The floral composition will be discussed later by SUZUKI who undertakes the study of this flora, but the occurrence of conifers and bog-bean may probably indicate the coldness for a period during the Würm glacial phase. Similar types of peat beds are found in this environs, for instance at Loc. Aiyoshi-II and at Tastuno-Shinmachi-II.

(4b) Aiyoshi plant beds (Aiyoshi-II)

Location: East of the town of Ono, Tatsuno-cho, N. Lat. 36°2.7'; E. Long. 137°59.0', Alt. : 830 m. a. s. l.

Absolute age: >30,000 C-14 years B. P. (GaK-158; KIGOSHI et al., 1962; KOBAYASHI and SHIMIZU, 1962, p. 33).

Stratigraphic position: The Aiyoshi plant beds which once yielded cones of *Picea bicolor* ? has been confirmed as an exact correlative of the Ono *Menyanthes* beds, because the pumice layer in the depth from 245 to 275 cm. (See p. 33 and 37 of our previous paper of 1962) proves, in heavy mineral composition, to be the Pm-III.

(5) Wakamiko-Shinmachi plant beds (Wakamiko-Shinmachi-II)

Location: 500 m. northeast of a small town of Shimmachi of Waka-miko, Yamanashi prefecture, N. Lat. 35°46.7'; 138°0', Alt. : 530 m. a. s. l.

Stratigraphic position: The beds are located north of a bridge across the railway of the Chuo line, and their floral aspect seems to be of particular interest. Here in a part of a cliff, the air-laid Pm-I unconformably covers a lacustrine alternation of diatomaceous silt, tuff and biotite-bearing sand or pumices. The beds below the unconformity are of water-deposition and all these beds change into diatomaceous beds seemingly toward the center of the former lake or pond. To the right of this exposure, higher parts which belong to the beds below the unconformity are found uneroded, and plant remains are contained throughout entire section of the beds below the unconformity.

According to Y. GOHARA, S. KAWACHI and others who have long concerned a work of stratigraphy of volcanic products of Yatsugatake volcanoes, these deposits as a whole are upon the surface of the Nirasaki complex of pyro-

clastic flows, mudflows and lava flows, which date they cannot exactly infer but prefer assigning it roughly to Middle Pleistocene time. No examples of magnetic reversal have yet been detected from these products.

Climatic implication: This autumn, while we were hunting plant fossils around Yatsugatake volcanoes, SUZUKI recognized that the beds yielded remains of broad-leafed trees such as *Castanea crenata* and *Wisteria*. Further hunting is needed for the confirmation of this floral assemblage, but according to his inference, it has an aspect of warm-temperate flora, presumably indicating the warmth of the Riss-Würm Interglacial.

(6) Kamikuroda peat beds

Location: A riverside cliff near Miyasaki, Iida City, N. Lat. 35°32.0'; E. Long. 137°50.3'; Alt. : 550 m. a. s. l.

Stratigraphic position: The peat seams are embedded within the Tagiri gravel, an equivalent of the Takao gravel, and are just above the horizon of pumice bed assignable to some of pumice beds of Older Loam, but the identification of any of these has not yet been made.

Two researchers undertook palynological study for this peat bed. According to NASU, the pollen assemblage is characterized by dominance of *Pinus* of Diploxylon type which amounts to nearly half of the total, and far less number of *Abies*, *Picea* and *Tsuga*. Broad-leafed trees include a few number (less than 10%) of *Alnus*, *Betula*, *Carpinus*, *Quercus*, *Salix* and *Juglans*. The Kamikuroda peat bed is located at the eastern foot of lofty mountains of the Central Japanese Alps, so that the assemblage may not always demonstrate a cold climate.

(7) Kuramoto-Yukawa plant beds

Location: Near Tanohara Spa on the eastern slope of Ontake volcanoes, Mitake-mura, Shinshu, N. Lat. 35°53.3'; E. Long. 137°35.3', Alt. : 1,200m. a. s. l.)

Stratigraphic position: The beds are exposed in the valley of the Yukawa flowing down the eastern slope of Ontake volcanoes. The beds which once filled the former valley, have been overlain by a set of lava flows which, according to Takehiko KOBAYASHI, are designated, from lower to upper, as the Hontani, Tsuchiguro-zawa and Kurakoshi-hara lavas, of which the last one is the so-called "Lava M-6" of KOZU (1908), and in lithology is a black and glassy hornblende andesite. The Kurakoshi-hara lava flows are partly covered by the Komikasa lava flows and they are all unconformably capped by the aeolian Pm-I.

Climatic implication: Lithologically, the plant beds are whitish, tuffaceous and well-laminated deposit, and show at some parts of exposure peculiar sedimentary structures like the involution formed under periglacial environ-

ment. But the climate suggested by this flora is quite another, because the floral assemblage is characterized exclusively by broad-leaved trees, implying that the climate was not dissimilar to that of present days.

Based upon the succession of volcanic events mentioned above, it is inferred, on the one hand, that the plant beds may date back to ages far older than that of the Pm-I. Hence, the climate indicated by this flora may probably demonstrate a warmth prior to the Riss-Würm Interglacial, possibly that of the Mindel-Riss Interglacial. Absolute age determination of these lava flows, if possible, will essentially be crucial for this problem.

(8) Plant beds associated with the Pm-I

a) Lignite beds at Yochi (Yochi-II)

Location: A big cliff south of Yochi, 7 km. west of the town of Ina City, N. Lat. 35°51.4'; E. Long. 137°53.7', Alt. : 970 m. a. s. l. (Fig. 3-b, 8).

Stratigraphic position: Lignites are enclosed within the Pm-I, at the exposure of the MK 1 gravel.

b) Oshio peat beds

Location: Oshio, northeast of the town of Chino, southwest of Lake Suwa, N. Lat. 36°9'; E. Long. 138°13.9'; Alt. : 940 m. a. s. l.

Stratigraphic position: According to S. KAWACHI and K. KITAZAWA, peat beds associated with the Pm-I are found at many places near Oshio. The palynological study of these peat beds will clear the climatic condition when the Pm-I was deposited.

(9) Plant beds below the Pm-I

a) Kobuchizawa lignite-bearing peat beds

Location: Railway-cut 2 km. east of the town of Kobuchizawa, Yamanashi prefecture, N. Lat. 35°50.9'; E. Long. 138°20.0', Alt. : 860 m. a. s. l.

From plant beds immediately below the Pm-I, SUZUKI recognized a cone of *Picea cf. bicolor*.

b) Yatsude lignite-bearing peat beds

Location: Yatsude east of the town of Ina City, N. Lat. 35°52.6'; E. Long. 138°0'; Alt. : 700 m. a. s. l.

c) Nyuyama plant beds

Location: Nyuyama 6 km. SEE of the town of Ina City, N. Lat. 35°48.0'; E. Long. 138°0', Alt. : 780 m. a. s. l.

Both plant beds at the former and this localities are embedded within the Rokudohara or the Oizumi gravel, and stratigraphically are more than 10m. below the Pm -I.

(10) Bison from Hiraide

Location: Hiraide, Tatsuno-cho, N. Lat. 35°58.8'; E. Long. 138°0.5', Alt. : 740 m. a. s. l.

Stratigraphic position: Organic matters have scarcely been found from the air-laid Loam formation, perhaps owing to extremely meagre Ca content in Loamy materials. Therefore, it must be the rare case that the junior author got several molars from a horizon just below the Pm-III of the air-laid Middle Loam at Hiraide. The fossils were identified by T. KAMEI to be molars of bison, of which palaeontological report will soon be published. Though no plant remains have been obtained from that horizon, tephrochronologically it is correlated with the Ono *Menyanthes* beds.

5 Summary and Acknowledgements

This is a preliminary report of somewhat an essential part of tephrochronological study mainly made in the Ina valley since the last publication of our paper (KOBAYASHI and SHIMIZU, 1962). Tephrochronological study thus being carried in this district and its environs presents for further studies such many clues as micro- and mega-fossil flora closely associated with tephra horizons. These clues may permit us to get detail chronological and climatological informations from the Quaternary events in these districts. Our study has been advanced through only stratigraphic works, except for a few radiocarbon dates obtained from very limited samples. The purpose of the present paper includes the presentation of a chronological base for further studies.

Anyhow, it is stressed from our study that no indications of warmer climate have been detected within a sequence of deposits younger than the period when the Wakamiko-Shinmachi plant beds were deposited. Additionally, the Pm-I has well been traced into the Shimosueyoshi Loam which conformably covers the surface of the Shimosueyoshi formation—a transgressive deposit (KOBAYASHI, 1965 a, b). Hence, the Shimosueyoshi marine transgression should be understood as the last major transgression having occurred during Pleistocene time.

Exact stratigraphic situation of the Older Loam unit has remained for future studies, owing to a few exposures and an intensive weathering of primary minerals contained in it.

We have obligations to record kind helps offered by two geobotanists, Dr. K. SUZUKI, Department of Geology, Fukushima University, and Dr. S. KOKAWA, Department of Botany, Osaka City University. We are also indebted to Mr. Y. GOHARA of our Department of Geology, and to Dr. S. KAWACHI, Mr. T. KOBAYASHI, Mr. K. KITAZAWA, and Mr. T. NASU for their cooperation.

References

- KIGOSHI, K., Y. TOMIKURA, and K. ENDO (1962) Gakushuin Natural Radiocarbon measurements I, *Radiocarbon*, **4**, pp. 84-94
- QUATERNARY RESEARCH GROUP OF KISO VALLEY, and K. KIGOSHI (1964) Radiocarbon date of the Kisogawa volcanic mudflows and its significance on the Würmian chronology of Japan, *Chikyu Kagaku*, **71**, pp. 1-7
- KOBAYASHI, K. (1958) Quaternary glaciation of the Japan Alps, *Jour. Fac. Lib. Arts and Sci., Shinshu Univ.*, **8**, pp. 13-67
- (1960) Bearing of "Shinshu Loam" on the Pleistocene geology of Matsumoto basin in Central Japan, *Jour. Fac. Lib. Arts and Sci., Shinshu Univ.*, **10**, pp. 21-67
- (1961) The so-called "Shinshu Loam", *Jour. Geol. Soc. Japan*, **67**, pp. 32-47*
- (1965 a) Late Quaternary chronology of Japan, *Chikyu Kagaku*, **79**, pp. 1-17
- (1965 b) Problems of Late Pleistocene history of Central Japan, *Spec. Paper Geol. Soc. Amer.*, **84**, pp. 367-391
- (1965 c) Radiocarbon dates of Totchu conifer bed, Akashina-cho, Nagano prefecture, *Chikyu Kagaku*, **81**, p. 44 *
- KOBAYASHI, K. and H. SHIMIZU (1962) Pleistocene tephra in the northern part of Ina valley, Central Japan, *Jour. Fac. Lib. Arts and Sci.*, **12**, pp. 20-45
- KOBAYASHI, K., H. SHIMIZU, and K. KITAZAWA (1965) The pumice bed Pm-I from the Ontake volcano, found in the South Kanto plain, *Quat. Res.*, **4**, p. 37 (abstract)*
- KOZU, S. (1908) Report of geology of Ontake volcanoes, Kiso, *Shinsai Yobo Chosakai Hokoku*, **59**, 63 pages.
- MORRISON, R. B. and J. C. FRYE (1965) Correlation of the Middle and Late Quaternary successions of the Lake Lahontan, Lake Bonneville, Rocky Mountain (Wasatch Range), southern Great plains, and eastern Midwest areas, *Nevada Bureau of Mines, Report* **9**, 45 pages
- SAKAI, J. (1963) The Shinshu Loam in Kiso valley, Central Japan (I) (II), *Chikyu Kagaku*, **67**, pp. 13-20; **68**, pp. 19-21*
- SHIMIZU, H., K. KOBAYASHI, and K. KITAZAWA (1965) The pumice bed Pm-I from Ontake volcano, found in the Kofu basin and along the Katsura river, *Quat. Res.*, **4**, p. 36 (abstract)*
- SHIMIZU, H., K. KOBAYASHI, Y. GOHARA, K. KITAZAWA, S. KAWACHI, and T. KOBAYASHI (1965) The pumice bed Pm-I from Ontake volcanoes—an excellent tephra horizon, *Jour. Geol. Soc. Japan*, **71**, p. 360 (abstract)*
- YAMAGATA, O. (1957) A palynological study of a *Menyanthes* bed from Nagano prefecture, Japan, *Ecol. Rev.*, **14**, pp. 267-268

* in Japanese

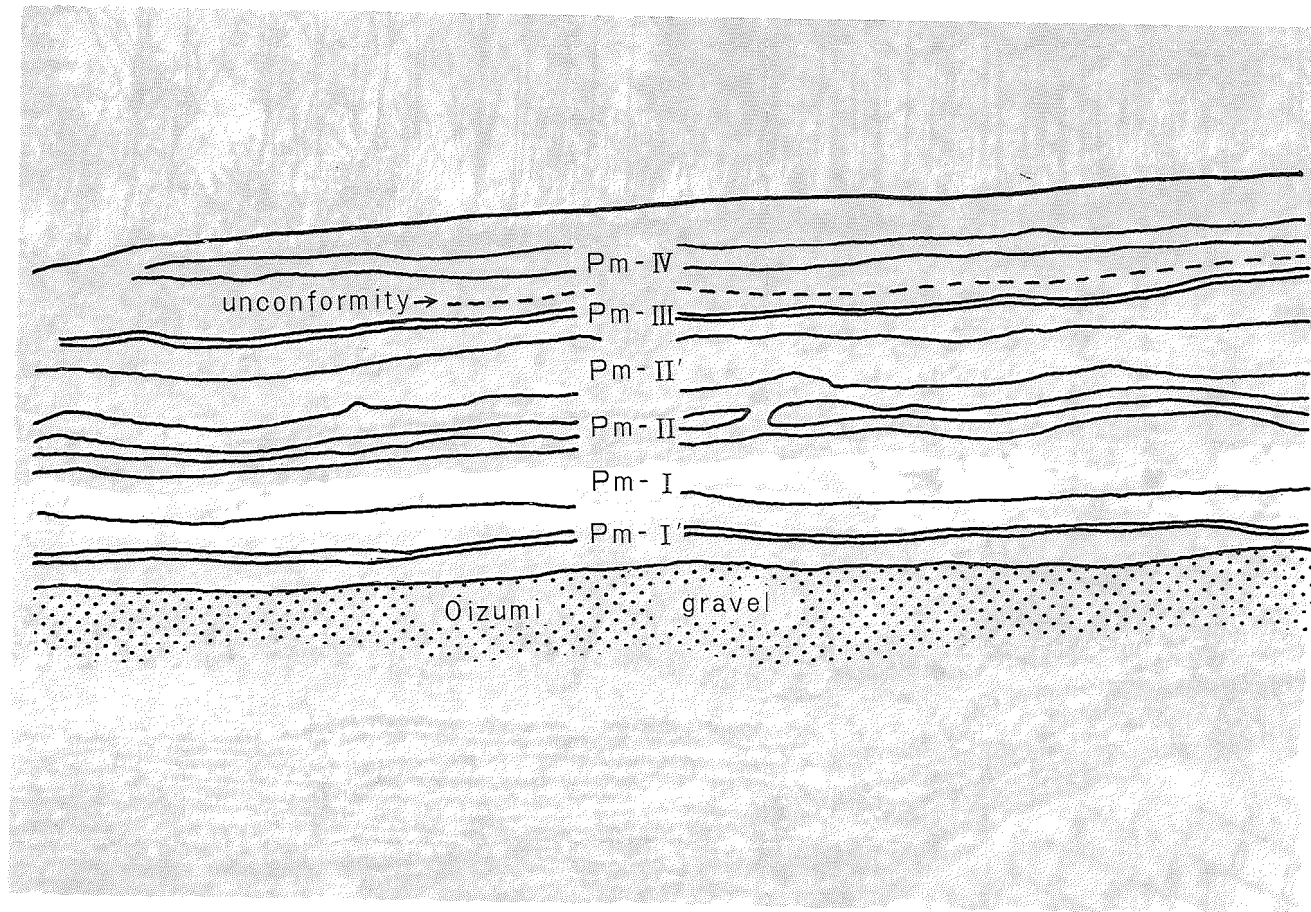




Fig. 1. Type section of Middle Loam and a lower part of Younger Loam at the Ina-Higashi Junior High School. From lower to upper, pumice beds Pm-I', Pm-I, Pm-II, Pm-II', Pm-III and Pm-IV are indicated.

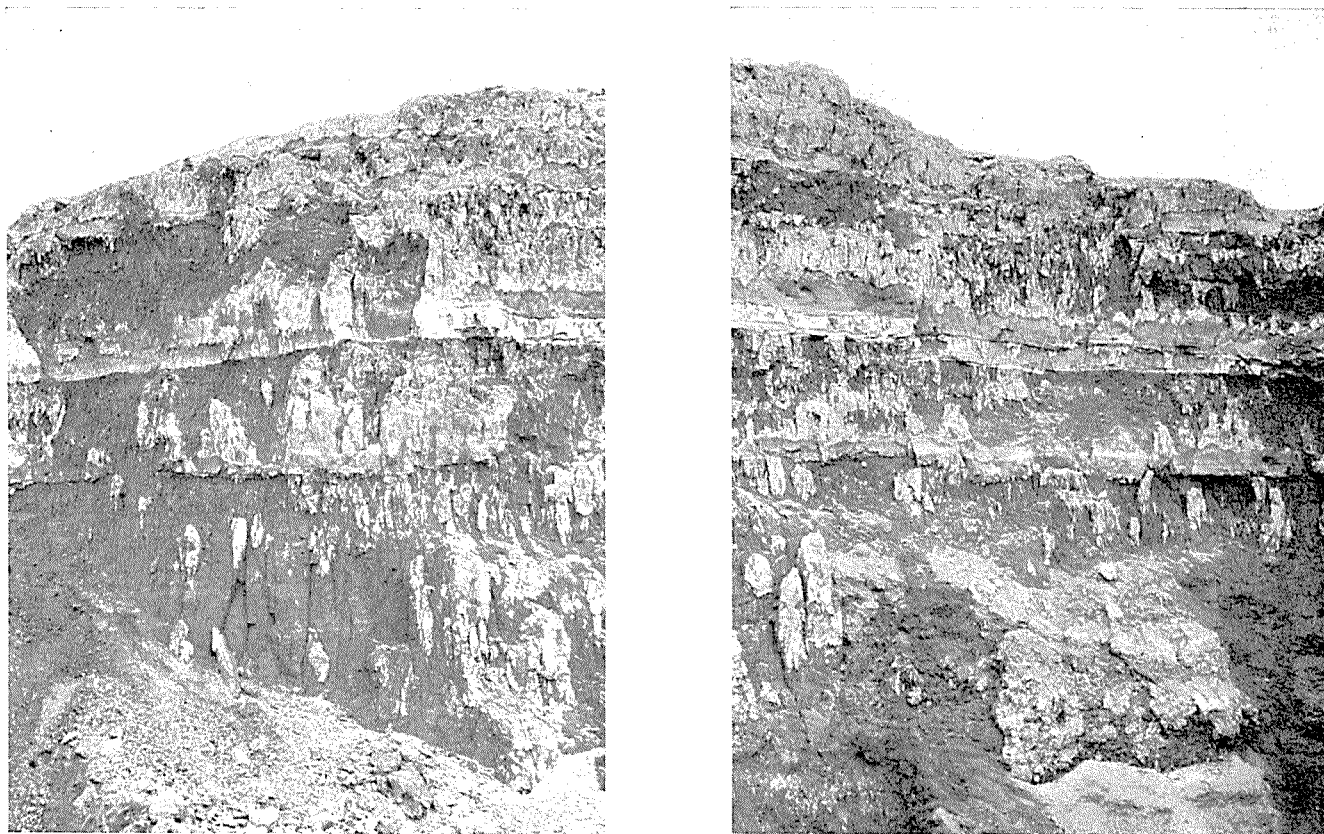


Fig. 2 and 3. Type section of Older Loam on Kojin'yama hill. From upper to lower, pumice beds designated as the Pm-01, Pm-02, Pm-03 and Pm-04 (the last two are well shown in the picture) are indicated.