3. Stratigraphy in the Kanto Tectonic Basin

The Kanto Tectonic Basin is a technical term to express the geologic and geomorphic features in the Kanto Region as shown in Chapter 2, but the present author deals with it as a place name but for precise explanation in this and following chapter.

A few marine and nonmarine formations, and many marine and fluvial terrace formations are distributed in the studied area (central to western parts of the Kanto Region) as show in Table 4. Stratigraphic classification of these formations had been confused. The author assembled a new stratigraphy in the studied area, and traced the newly named layers on the basis of the stratigraphy in the Tama Hills on the south and Fujioka City on the north (Fig. 1-2). The stratigraphy of the studied area and adjacent areas are discussed below (Tables 1, 2 and 4).

The marine terrace and volcanic ash formations are distributed in the studied area. The marine formations composes the basement of the terrace formation which is distributed on the upper part of the hill and plateau with the volcanic ash formation. Stratigraphy, correlation and chronology of these formations and alluvial deposits are the main theme of this study

(1) Yaoroshi, Hanno and Bushi Formations, Komiya Sand and Toyooka Gravel

The Yaoroshi Tuff is composed mainly of tuff and the Hanno Gravel is composed of gravel. The Yaoroshi Tuff was considered as thin layer until now, but is thicker than the Hanno Gravel at the below the plateau and valley plain. From the mentioned above, the author defines the name Yaoroshi Tuff to the Yaoroshi Formation and the Hanno Gravel to the Hanno Formation.

The comparisons of stratigraphic subdivision by Mitomo *et al.* (1986) and the present author are mentioned below and shown in Table 1.

The layers of the following table show maximum thickness.

Mitomo *et al.* (1986)

Upper Toyooka Gravel (12m)

(Terrace formation)

unconformity

Lower Toyooka Gravel (50m)

unconformity

Hanno Formation: Bushi Clay (100m); Hanno Gravel (100m); unconformity ?; Yaoroshi Tuff (270m)

unconformity

Basement rocks

(Mesozoic and Paleozoic)

Machida, M. (1999)

Kanekozaka Gravel (12m)

(Terrace formation)

unconformity

Toyooka Gravel (50m)

unconformity

Bushi Formation (100m)

Hanno Formation (100m)

unconformity ?

Yaoroshi Formation (270m)

unconformity

Basement rocks

(Mesozoic and Paleozoic)

a) Yaoroshi Formation (lower part of the Hanno Gravel of Fukuta and Takano, 1951: newly proposed name). (Figs. 3-1, 3-3, 3-4-1, 3-4-2, 3-5, Tables 1, 2, 4, Pls. 1 and 2)

Type locality: Mitomo *et al.* (1986) designated the type locality of the Yaoroshi Tuff (=Yaoroshi Formation) at a cliff along new road at the north of Shimohata, Hanno City. The formation of the present paper along the Iruma River at Yaoroshi, Hanno City, is well exposed and supplemental locality exposed continuously from the type locality. The Yaoroshi Formation covered by the Hanno Formation was traced almost successively from the south of the Oppe River to the fossilliferous bed called the Narahara Fossil Plant Bed (Narahara Fossil Plant Research Group, 1967) or the *Metasequoia* Fossil Forest (Fujimoto, 1977) of Narahara in Hachioji City along the Kita-asakawa River. The Yaoroshi Formation is exposed in the south of the Tama Mausoleum and is correlated to the Oyabe Formation (Masuda, 1971) of the lower part of the Kazusa Group in the Tama Hills (Table 2). Takegoshi *et al.* (1979) correlated the Hanno Gravel

(author's Yaoroshi and Hanno Formations) with the Oyabe Formation. Kikuchi (in Regional Geology of Japan, Kanto, 1986) mentioned the Narahara Fossil Plant Bed is correlated with the Oyabe Formation. The Yaoroshi Formation in the Tama Mausoleum is close to the Oyabe Formation of the Tama Hills because both are composed of similar lithofacies.

The Yaoroshi Formation becomes thick in the subsurface of the plain, and is not distributed in the eastern part of the hills, where the overlying Hanno Formation covers the Paleozoic rocks with unconformity.

Lithofacies : The Yaoroshi Formation covers directly the pre-Tertiary System with unconformity in high angle as mentioned by Fukuta and Takano (1951) and Takegoshi *et al.* (1979). Many outcrops in such relation between the Yaoroshi Formation and the pre-Tertiary System are observed in the area from Moroyama to Hachioji. The Yaoroshi Formation is rather widely distributed near the basement rocks at same altitude, such as Shukuyagawa, Hara, the Koma Musashidai Housing area in Hidaka City, neighborhood of the funeral of Hanno, Maeganuki Hills and southern entrance of Hata Tunnel in Hanno City, Ome Golf Courses, development land of Meisei University and Cemetery Park of Ome. The Pre-Tertiary basement rocks were crushed at the contact with the Yaoroshi Formation contained much pebbly rubbles of the basement rocks.

About 40 m thick upper part of the Yaoroshi Formation crops out but it increases as thick as 150 m in a borehole underground in Hanno City (Asami, 1988) and as 270 m underground in Hachioji City (Shindo, 1969). The Yaoroshi Formation is comprised with an alternation of angular gravel, tuffaceous sands and muds.

The thickness of the Yaoroshi Formation increases suddenly from the hills toward the plateaus and river plain. The Yaoroshi Formation was deposited in a past deep valley bottom between the hills. The Yaoroshi Formation is composed of thin and thick layers deposited in the valleys that were opened eastward.

The Yaoroshi Formation is brown to bluish gray in color and consists of only tuff with thin gravel bed. The lithofacies of exposed tuff differs from those of

underground that comprise alternations of gravel, tuffaceous sand and mud. About 1 to 2 m thick gravel bed is intercalated near the upper limit of the Yaoroshi Formation which is composed mainly of rounded cobbles that resemble the Hanno Formation as mentioned later.

The Yaoroshi Formation is overlaid by the Hanno Formation conformably but the sedimentary environments of the two are different. There is a difference in altitude of the upper limit of the Yaoroshi Formation due to the different erosion in eroded northward. The relation between the Yaoroshi and Hanno Formations are unconformity (?) in northward. The Yaoroshi Formation mainly consists of tuffaceous mud included subangular to angular gravels and intercalates thin tuffaceous sand and granules in some places. At the funeral of Hanno, Yaoroshi and Maeganuki Hills, the pumice beds are intercalated in the Yaoroshi Formation. Pumice grains are of diameter 2 to 4 mm (Pl. 2, fig. 1) and composes about 1 m thick layer at Yaoroshi. These pumice grains are come from the different volcanic eruptions. This pumice bed was intercalated at ten to several meters below from the upper surface of the Yaoroshi Formation. The Yaoroshi Formation intercalates the layers of white to pinkish white tuff that are applicable to the fission track age measurement. Research Group for Geology of the Western Hills of the Kanto Plain (1995) picked up the zircons from the Yaoroshi Formation in the Kasumi Hills and reported the fission track ages as mentioned later.

The Yaoroshi Formation includes the plant fossil stump, *Taxodioxylon sequoianum* (Merckl.) Gothan or *Taxodioxylon* ? sp. identified by Shimakura (1936). The fossil stump stood erect in mud showing as autochthonous occurrence. These occurrence are observed at river side cliffs and river valley floors at Yaoroshi to Maeganuki in Hanno City, from Chigase to Kawabe-cho in Ome City, and 4-chome, Osoki in Ome City. Mitomo *et al.* (1986) reported fresh water diatoms in the Yaoroshi Formation from the river cliff at 4-chome of Osoki, Ome City (Table 3). *Stegodon bombifrons* (Falconer and Cautley) was also discovered from the Yaoroshi Formation in Akiruno City (Itsukaichi *Stegodon* Research Group, 1980).

The erect trunks of gymnosperm and leaves of *Metasequoia, Pinus, Juglans,*

Fagus, Gleditschia, Nelumbo and *Trapa* (Narahara Fossil Plant Research Group, 1967) were reported from the equivalent formation with the Yaoroshi Formation in the bottom of the Kita-Asakawa River at Narahara in Hachioji City, besides pollens as *Sequoiadendoron, Abies, Carpinus* and *Polypodiisporites.* Kimura *et al.* (1981) reported the following fossil species from Narahara:

Picea cf. *maximowiczii* Regel, *Pinus fujiii* (Yasui) Miki, *Metasequoia* cf. *glyptostroboides* Hu and Cheng, *Juglans cinerea* Linné var. *megacinerea* Miki, *Quercus* sp., *Gleditschia* cf. *japonica* Miquel, *Buxus microphylla* Siebold and Zuccarini var. *japonica* Rehder and Wilson, *Paliurus* ? sp., *Trapa macropoda* Miki and *Trapa maximowiczii* Korshinsky.

Kurakawa and Majima (1982) obtained the plant remains as *Picea maximowiczii* Regel, *Pterocarya rhoiforia* Siebold and Zuccarini and others. They also discovered the following species from their Locality 3;

Picea koribai Miki, *Metasequoia disticha* Miki, *Sapium sebiferm* Roxb. var. *pleistoceaca* Miki, *Chamaecyparis pisifera* (Siebold and Zuccarini), *Alnus* sp., *Styrax* sp. and *Fagus* sp.

Research Group for Geology of the Western Hills of Kanto Plain (1995) published that the fission track ages of the upper part of the Yaoroshi Formation were 2.09±0.14 Ma and 2.01±0.24 Ma. According to the data, the geological age of the Yaoroshi Formation was formed at least late Pliocene. This age is close to 2.06±0.28 Ma by the fission track age of the O23, key tuff of the Otadai Formation in the Boso Peninsula (Suzuki and Sugihara, 1983). Further, Nakagawa (1988a) estimated that the Pliocene-Pleistocene boundary is between the Kd25 and Kd20 which are key tuffs in the Kiwada Formation underlying the Otadai Formation from the data of magnetstratigraphy and microfossil biostratigraphy. Nakagawa *et al.,* designated that the Pliocene-Pleistocene boundary is between the key tuffs of Kd38 and Kd20 as mentioned in Chapter 3, edited by Van Couvering (1997).

Suzuki and Sugihara (1983) dated the key beds of the Kiwada Formation by the fission track method and get the data as the Kd38D is 2.59±0.78 Ma, the Kd26 is 2.54±0.29 Ma and the Kd16 is 2.34±0.22 Ma. Hara and Sugihara (1990)

measured the key beds of the lower part of the Kiwada Formation and reported the data as that the Kd_{38e} is 2.02±0.21 Ma , the Kd_{23d} is 1.95±0.29 Ma, the Kd_{23e} is 1.94±0.12 Ma, the Kd_{18} is 1.71±0.17 Ma and the Kd_{16} is 1.63±0.31 Ma. Kasuya (1990) reported the fission track age of the Kd_{23} is 1.6±0.2 Ma. Concerning the progress of the detailed definition of the Pliocene-Pleistocene boundary, see the "History of definition of the Quaternary" in Chapter 2

Thickness: 0 to 40 m (surface), and 270 m or more in underground (Shindo, 1969).

b) Hanno Formation (upper part of the Hanno Gravel of Fukuta and Takano, 1951: newly proposed name) (Figs. 3-1, 3-2, 3-3, 3-4-1, 3-4-2, 3-5, 4-10, Tables 1, 2, 4, Pl. 2, fig. 2 and Pl. 3, fig. 1)

Type locality: The type locality of the Hanno Formation (upper part of the Hanno Gravel of Fukuta and Takano, 1951) is proposed herein at the cliff along the Koma River on the northern margin of the Hanno Hills in Hidaka City.

Lithofacies: The Hanno Formation consists of rounded gravels 70 to 5 cm of sandstone, mudstone, chert and quartz-diorite. Sorting of gravel is well in the east as mentioned by Fukuta and Takano (1951). Except chert, the weathering of the gravels were deep into the inside but chert is not weathered. The weathering of quartz-diorite is extremely distinct in particular. The weathering of the Hanno Formation and its equivalents is not so violent as that of terrace gravel of the "Tama Terrace Group". In the Iwadono and Yoshimi Hills, only a few rounded gravels of quartz-diorite are included in the Hanno Formation. The components of the gravels are mostly of crystalline schist in the Iwadono and Yoshimi Hills. The hills were probably situated at their source rocks.

The matrix of the gravels is brown to yellowish brown or bluish gray tuffaceous silt and clay. The matrix increases toward the lower part and the Hanno Formation is consolidated in this part. The sandy matrix increases upward but the matrix in some places is lacking.

The Hanno Formation in the Hanno and Azuyama Hills is also recognized as

the Yoshimi Gravel in Yoshimi Hills, Monomiyama Gravel in Iwadono Hills, Moroyama Gravel in Moroyama Hills, Mitsugi Gravel in Sayama Hills, Onita Gravel in Kusabana Hills, Kasumi Gravel in Kasumi Hills and Hirayama Sand in the western part of the Tama Hills.

The Mitsugi Gravel (Hatori and Juen, 1958) in the Sayama Hills (Fig. 3-2) is the lowest member of the Sayama Formation (Makiyama, 1930) and was correlated with the Hanno Formation by Sakamoto *et al.* (1987).

The gravels in the Hanno Formation and its equivalents were transported from the Kanto Mountains by the Tama, Sagami, Akigawa, Iruma, Koma, Oppe and Arakawa Rivers. The gravels of Hanno Formation transported by the Tama River are distributed over the Azuyama, Kusabana and Sayama Hills.

The equivalents of the Hanno Formation in the Iwadono and Yoshimi Hills are composed of cobbles to pebbles of chert, slate and sandstone in the Moroyama Hills. The diameter of gravel becomes small in the east.

From the geographic distribution in the Hanno Hills, the transportation of gravels in the Moroyama, Iwadono and Yoshimi Hills on the north of the Hanno Hills was not by the Tama River but by the Koma and Oppe Rivers flowing in the north of the Tama River. The Koma and Oppe Rivers were probably the distributaries of the Tama River that flowed across the same alluvial fan.

The gravels in the southern part of Kasumi Hills are composed of cobbles transported by the Tama and the Akigawa Rivers that flowed through Akiruno City.

In the western part of the Tama Hills, the Hirayama Sand (Masuda, 1971, Tables 2, 4, Pl. 3, fig. 2 and Pl. 4, fig. 1) is distributed. The Hirayama Sand is composed mainly of massive and coarse grained sand (Pl. 4, fig. 1). In the western part of the Tama Hills, the Hirayama Sand is composed of pebbles (Pl. 3, fig. 2). Sand and gravel of the Hirayama Sand were probably transported by the Sagami River flowing down from the west of the Tama Hills to the Musashino Plateau on the east (Oka, 1991). The Hirayama Sand is distributed in the southeastern margin of the Kanto Mountains. The sedimentary environment of

the Hirayama Sand changes laterally from the alluvial fan to deltaic coast. The molluscan shells of a shallow sea sand bottom including *Mizuhopecten* cf. *yessoensis, Rapana* cf. *venosa, Macoma incongrua* and *Venericardia ferruginea* were reported in the Hirayama Sand (Igo *et al.*, 1980; Regional Geology of Japan, Kanto, 1986).

The Hanno Formation covers the Yaoroshi Formation with conformity at type locality of the Yaoroshi Formation but with unconformity in the north. The gravel as facies correlated with the Hanno Formation does not exist in the northern part of the Yoshimi Hills and the Hanno Formation covers directly the Miocene deposits with unconformity.

The Azamiyama Gravel distributed in the Matsuhisa and Kodama Hills on the north of the Arakawa River consists of cobbles to pebbles sized sandstone, mudstone, chert and crystalline schist. Among them only the chert is not weathered. Probably the Azamiyama Gravel corresponds to the "Tama Terrace Group".

The gravel distributed around the Mt. Kannon in the western part of the Kumagaya City is not weathered and the rounded cobble of chert is remarkable. The upper part of the gravel intercalates the tuff beds. As the dip of the gravel is steeper than 30 degrees, the gravel is older than the Hanno Formation in age. The gravel overlying the Yagii Formation on the Arakawa River floor is similar to the degree of weathering and matrix to the Hanno Formation, but direct correlation by lithology is difficult because lithofacie of the gravel overlying the Yagii Formation differs from the Hanno Formation. The gravel may be correspondent with the Hanno Formation.

The fossil plants, *Abies, Picea, Pinus, Tsuga* and *Larix* were discovered from a dark gray clay lens in the upper part of the Hanno Formation and *Abies* was abundant at the horizon (Suzuki and Yoshida, 1969).

Thickness: Thickness of the Hanno Formation and its equivalents change in the areas as 25 m in Yoshimi Hills, less than 70 m in Iwadono Hills, 50 m in Moroyama Hills, 80 m in Hanno Hills, 100 m in Azuyama and Kusabana Hills and

85 m in the Kasumi Hills. The Mitsugi Gravel is 50 m thick in the drillhole (Hatori and Juen, 1958).

c) **Bushi Formation** (Fujimoto, 1939: redefinition, Horiguchi *et al.*, 1977) (Figs. 3-1, 3-2, 3-3, 3-4-2, 3-5, 4-10, 4-11, Tables 1, 2, 4, Pl.4, fig. 2 and Pl. 5, fig. 1)

Type locality: Road side cutting at Bushi, Iruma City (Fujimoto, 1939). Fukuta and Takano (1951) renamed it as the Bushi Clay that was preoccupied by the Bushi Formation (Fujimoto, 1939). Horiguchi *et al.* (1977) defined the Bushi Formation for Bushi Clay (Fukuta and Takano, 1951) and the type locality along the Iruma River between the cutting of a road at Bushi and 300 meters down stream of the Sasai Dam. At the time Horiguchi *et al.* (1977) subdivided the Bushi Formation into five members as A, B, C, D and E in ascending order (Fig. 3-1).

Lithofacies and distribution: The Bushi Formation is mainly distributed around the Azuyama Hills and well exposed at river side cliffs of the Iruma River. In the Azuyama Hills, the Bushi Formation is about 30 m thick and over 100 m thick along the Iruma River. According to the classification of Horiguchi *et al.* (1977) the A Member overlies the Hanno Formation with conformity on the river-side at Bushi, Iruma City and consists mainly of tuffaceous silt with intercalation of lignite and volcanic ash. The B Member consists of gravel and silt. Sandpipes, molluscan shells and plant fragments are yielded from silt. The lower part of the C Member is gravel of 8 m thick and the upper part is silt with same thickness to the lower part. The D Member is composed of gravels of 4 m thick at lower part and tuffaceous silt of ten and several meters thick at upper part. The E Member consists of gravel with several meters thick at the lower part, and the sand in the middle to upper parts. The lignite is recognized in the upper part and is known as the fossil forest of *Metasequoia* at Sasai, Sayama City. Many angular pebbles and granules intermingle in lignite bed.

The Yatsu Clay (Fig. 3-2 and Table 4; Hatori and Juen, 1958) of the middle Member of the Sayama Formation (Makiyama, 1930) in the Sayama Hills overlies

the Mitsugi Gravel (equivalent to the Hanno Formation) with conformity and is correlated with the Bushi Formation (Sakamoto *et al.* 1987). The Yatsu Clay is exposed at the western to middle parts of the Sayama Hills, and correlated with the A to D Members of the Bushi Formation along the Iruma River. It was already expecting by Saitama Research Group and Kanto Quaternary Research Group (1970). The distribution of the Yatsu Clay is drawn on the geological map of Tokyo in a scale of 1/200,000 by Sakamoto *et al.* (1987). In the Regional Geology of Japan, Kanto (1986), the Bushi Formation is shown on the map and the Hanno Formation is not in the Sayama Hills. Then the Bushi Formation is distributed in the western part of the Tama Hills where includes an alternation of the Renkoji Formation (Masuda, 1971).

Takegoshi and Muramatsu (1994) reported the fission track age of 1.03±0.07 Ma for the E 1 Volcanic Ash intercalated in the lower part of the E Member.

Stegodon aurorae were discovered from the seven horizons in the lower to upper parts of the Bushi Formation. The Bushi Formation was deposited in the land condition. The D Member of the Bushi Formation has been known as the Ushizawa shell bed (Tokunaga and Iizuka, 1926). The following fossils were reported from the D Member,

Pleurotoma ? sp. *Anadara* (*Tegillarca*) *granosa bisenensis* Schenck et Reinhart, *A.* (*Scapharca*) *broughtoni* (Schrenck), *Crassostrea gigas* Thunberg, *Felaniella usta* (Gould), *Lucinoma annulata* (Reeve), *Cyclina orientalis* Sowerby and *Macoma nipponica* (Tokunaga). Tokunaga and Iizuka (1926) reported mentioned *Ostrea* (*C.*) gigas is dominant among the species.

Mori *et al.* (1974) reported the following species from the Ushizawa shell bed:

Batillaria zonalis (Bruguière), *Cerithidea djadjariensis* (Martin), *Anadara (Tegillarca) granosa* (Linnaeus), *A.* (*Scarpharca*) *subcrenata* (Lischke), *Anomia lischkei* Dautzenberg and Fischer, *Crassostrea gigas* (Thunberg), *Corbicula japonica* Prime, *Trapazium liratum* (Reeve), *Lucina stearesiana* Oyama, *Dosinia penicillata* (Reeve), *Cyclina orientalis* (Sowerby), *Clementia vatheleti* Mabille and *Macoma incongrua* var. (Martens). Those species are of an environment of the

tidal zone. Aside of these species, *Neptunea* was collected.

Obata (1997) reported the following molluscan species from the Ushizawa shell bed:

Cerithideopsis djadjarensis (Martin), *Batillalia* cf. *zonalis* (Bruguière), *Neptunea* (*Barbitonia)* sp., *Scapharca* cf. *subcrenata* (Lischke), *Tegillarca granosa* (Linnaeus), *Septifer* (*Mytilisepta*) cf. *keenae* Nomua, *Solamen spectablis* (Adams), *Anomia* sp., *Crassostrea gigas* (Thunberg), *Lucinoma* sp., *Cycladicama* sp., *Diplodonta gouldi* Yokoyama, *Merisca* (*Pistris*) *subtruncata* (Hanley), *Fabulina* cf. *peitahoensis* (Grabau and King), *Macoma* (*Macoma*) *incongrua* (Martens), *Trapezium* (*Neotrapezium) liratum* (Reeve), *Ruditapes philippinarum* (Adams and Reeve), *Paphia* ? sp., *Cyclina sinensis* (Gmelin) and *Thracia* ? sp. Those are expected to alive on an environment of the tidal zone with sandy bottom.

This shell bed is rich in foraminifers. Fukuta and Takano (1951) reported *Elphidium planum* Husezima et Maruhashi, *E. etigoense* Husezima et Maruhashi, *Rotalia beccarii* (Linnaeus) and others.

The fossil stumps of *Metasequoia* were autochthonously found from the E Member at Sasai, Sayama City. Kimura *et al.* (1981) discovered the following plant fossils at the same locality:

Metasequoia cf. *glyptostroboides* Hu and Cheng, *Salix* cf. *integra* Thunberg, *S.* sp., *Alnus* cf. *japonica* Siebold and Zuccarini, *Ilex cornuta* Lindley and Paxton and *Trapa maximowiczii* Korshinsky.

Board of Education of Sayama City (1982) reported the occurrence of *Metasequoia disticha* Miki, *Juglans megasinerea* Chaney, *Styrax japonica* Siebold and Zuccarini, *S.* sp., *Alnus japonica* (Thunberg) Steud, *Pterocarya* sp., *Magnolia kobus* DC., *Zanthoxylum ailanthoides* Siebold and Zuccarini, *Vitis* sp. and Rosaceae.

Sasai Fossil Research Group (1984) reported the occurrence of *Metasequoia disticha* Miki, *Alnus japonica* (Thunberg) Steud., *Sapium* ?, *Wistaria* sp., *Polygnum* sp., *Styrax japonica* Siebold and Zuccarini, *Juglans megacinerea* Chaney, *Quercus serrata* Thunberg and *Quercus* sp.

Thickness: Over 110 m along the Iruma River and 30 m in the Azuyama and Sayama Hills (the upper part is lacking in both hills).

d) **Komiya Sand** (Figs. 3-3, 3-4-2, Tables 2 and 4)

Type locality: The riverside cliff along the Akigawa River at Takiyama-cho, Hachioji City (Kurakawa and Majima, 1982).

The Komiya Sand overlying the Kasumi Gravel (equivalent to the Hanno Formation) in the Kasumi Hills with conformity is distributed in the eastern part of the Kasumi Hills. The western limit of distribution of the Komiya Sand is a small valley to the south of the Fudo Temple at Takatsuki-cho, Hachioji City (Kurakawa and Majima., 1982) and the eastern limit is covered by the Hino Gravel in the Hino Plateau on the east of the Kasumi Hills (Fujimoto *et al.*, 1926). The Komiya Sand is subdivided into the two parts. The lower part consists of a massive fine grained sand of yellowish gray in color and includes thin lenses composed of rounded to subrounded pebbles. The upper part consists of a gravel and irregular alternation of fine grained sand, silty fine grained sand, graveliferous fine grained sand, gravel and silt.

The Komiya Sand covers the Kasumi Gravel with conformity, and is covered by the Mine Gravel with unconformity. The Komiya Sand is about 20 meters thick and corresponds to the lower part of the Bushi Formation. Fossil cetacea, *Japonocetus akishimensis* Nishiwaki and Ozaki was discovered by Ozaki and Akishima Earth Science Research Group (1962). Thin fragmental shell bed composed of *Ostrea* is also reported by Juen (1966a).

Thickness: About 20 m.

e) **Toyooka Gravel** (Fukata and Takano, 1951: Machida, M. 1973, revised redefinition in this paper) (Figs. 3-1, 3-3, 3-4-2, Tables 1, 2 and 4)

Type locality: The type locality was defined at a cutting along new road in the Azuyama Hills on the west of Bushi, Iruma City (Fukuta and Takano, 1951). In 1973 (Machida, M.,), the Toyooka Gravel is subdivided into two parts with

unconformity. The lower part of the Toyooka Gravel was deposited under the similar environment with that of the Bushi Formation. The upper part of the Toyooka Gravel is the terrace gravel. The upper part of the Toyooka Gravel should be contemporaneous with the Kamikayama and Imokubo Gravels as stated in the following chapter. The present author substitutes herein the Toyooka Gravel is used for the Lower Toyooka Gravel as stated by Fukuta and Takano (1951) and the Kanekozaka Gravel for the Upper Toyooka Gravel.

Lithofacies: The Toyooka Gravel distributed in the eastern half of the Azuyama Hills is mainly composed of sand and gravel. The sand is tuffaceous and gravels is composed of boulder to pebble size of shale, slate, graywacke, chert and quartz-diorite.

The Toyooka Gravel consists of an alternation of gravel, tuffaceous sand and tuffaceous clay with white clayey pumice. The matrix of gravel is coarse to medium grained sands. The Toyooka Gravel is brown, light brown and orange brown at the weathered surface.

The direct contact of the Toyooka Gravel and Bushi Formation has not been recognized owing to poor exposure. The Toyooka Gravel is overlain by the Kanekozaka Gravel with unconformity (Machida, M., 1973). The cherts as main component of gravel included as 20 % of the total are not weathered although other rocks are deeply weathered especially at just below the Kanekozaka Gravel.

Thickness: About 50 m.

(2) Terrace Gravels and Alluvial Deposit

a) Kanekozaka Gravel (new name)

The present author newly proposed herein the Kanekozaka Gravel (Table 4) for the Upper Toyooka Gravel (Machida, M., 1973). The stratigraphic succession of the Kanekozaka Gravel and the overlying volcanic ash in the Azuyama Hills are the same as that of the Imokubo Gravel (Pl. 5, fig. 2) and the Tama I Volcanic Ash in the Sayama Hills.

Type locality: The cliff near the entrance to the Kakuho-danchi on the eastern side of the summit of the Kanekozaka Pass, at Kaneko, Iruma City, Saitama Prefecture.

Lithofacies: The Kanekozaka Gravel is distributed intermittently between the Kanekozaka Pass and the ridges of the eastern part of the Azuyama Hills. The Kanekozaka Gravel is composed of gravels as of the Toyooka Gravel.

The basal part of the Kanekozaka Gravel is mainly composed of cobbles of chert and matrix of coarse grained sand. More than half of cherts are in cobble size and becomes smaller upward into pebble size.

Sorting of chert is poor in the basal part and becomes better upward, but poor again at the top. The rounded to subrounded gravels consist of sandstone, slate and chert, and almost all of which were originated from the Mesozoic and Paleozoic formations. Quartz-diorite rarely included were originated from the Neogene Series. In the Kanekozaka, Kamikayama and Imokubo Gravels, subround to subangular pebbles and granules of white tuff or siltstone are studded. Judging from the consolidation, this white tuff or siltstone was probably originated from the Tertiary Series. The matrix of the Kanekozaka Gravel is mainly composed of coarse grained sand, chert and tuffaceous rocks, and increases upward. The gravel of chert is fresh but other kinds of the gravel are almost weathered and the matrix was remained fresh.

The Kanekozaka Gravel is covered by the Tama I Volcanic Ash as same as the Kamikayama Gravel in the Hanno Hills and the Imokubo Gravel in the Sayama Hills with conformity.

Shimizu and Horiguchi (1993) reported the stratigraphy of the volcanic ash covering the gravel. From the stratigraphic profiles, the author confirmed that the relation between the Kanekozaka Gravel and overlying volcanic ash in the Azuyama Hills is the same relation as between the Imokubo Gravel and the Tama I Volcanic Ash in the Sayama Hills. The Kanekozaka Gravel is 10 to 12 m thick, and is brown to orange in colour.

b) **Kamikayama Gravel** (Machida, M., 1973)(Fig. 4-2 and Table 4)

Type locality: Exposure in the abandoned pit in Kamikayama, Hidaka City, Saitama Prefecture (Machida, M. 1973).

Lithofacies: The Kamikayama Gravel (Fig. 4-2) consists mainly of cobbles and pebbles of sandstone, shale, slate and chert. The pebbles of chert are mostly not weathered.

The weathered degree of gravels is the same as of the Kanekozaka Gravel. The upper part of the gravel consists of poorly sorted subrounded to subangular pebbles and granules. The gravel interfingers with the overlying the Tama I Volcanic Ash. The matrix of the gravel is coarse to medium grained tuffaceous sand and clay. The base of the gravel is concealed. Therefore the thickness of ther gravel is not known (No. 2 of Fig. 4-2). The Kamikayama Gravel is brown and orange brown in colour. This gravel is continuous to the Kanekozaka and Imokubo Gravels.

c) **Imokubo Gravel** (Hatori and Juen, 1958)(Fig. 4-3, Table 4 and Pl. 5, fig. 2)

Type locality: Imokubo in Higashiyamato City, Tokyo Metropolis (Hatori and Juen, 1958).

Lithofacies: Hatori and Juen (1958) divided the Sayama Formation (Makiyama, 1930) into three members; Mitsugi Gravel, Yatsu Clay and Imokubo Gravel in ascending order. The Imokubo Gravel is mainly composed of rounded to subrounded pebbles with cobble and granule of sandstone, siltstone and chert. Matrix is coarse to medium grained sand, tuffaceous sand and clay. This is a

terrace formation of the Sayama Terrace. Partly the Imokubo Gravel intercalates coarse grained sand bed. Weathering degree of gravels in the Imokubo Gravel is the same as that of the Kanekozaka and Kamikayama Gravels. Decolorized white to silver grains of biotite are concentrated in several horizons.

The Imokubo Gravel is also distributed beneath the Alluvial plain at Tabata, Tokorozawa City, on the eastern part of the Sayama Hills. The matrix of the Mitsugi Gravel is medium grained sand and clay. The diameter of gravel of the Mitsugi Gravel is smaller than that of the Imokubo Gravel. The Kanekozaka, Kamikayama and Imokubo Gravels are continuous with each other. The Imokubo Gravel as well as the Kanekozaka and Kamikayama Gravels is covered by the Tama I Volcanic Ash. The Imokubo Gravel as well as the Kanekozaka and Kamikayama Gravels. The Imokubo Gravel is older than the Upper, Middle and Lower Gotentoge Gravels in the Tama Hills (Oka and Unozawa, 1989). The Kanekozaka, Kamikayama and Imokubo Gravels are the oldest terrace gravel in the southern part of the Kanto Region.

d) Mine Gravel (Hatori and Juen, 1958)(Table 4)

Type locality: Road side cutting at the pass from Haijima-cho, Akishima City to Sanyu-cho, Hachioji City along the eastern part of the Kasumi Hills (Hatori and Juen, 1958).

The Mine Gravel is mainly composed of pebbles and granules of sandstone, graywacke, chert and slate. The matrix of the gravel is medium grained sand and partly clay. According to Hatori and Juen (1958), the lower half of the gravel consists mainly of pebbles and granules, and the upper half of Mine Gravel is clayey sand. The lower half of the Mine Gravel includes partly the volcanic sand and ash. The Mine Gravel is distinguished from the Kasumi Gravel that is including cobbles of diorite and phyllite, with clastic matrix. Subrounded pebbly mud blocks distinguish from those of underlying the Komiya Sand. The Mine Gravel is about 15 meters thick and overlies the Komiya Sand unconformably. The Mine Gravel is covered by the volcanic ash with conformity as Kurakawa and

Majima (1982) reported that the Mine Gravel is covered by the middle part of the Tama I Volcanic Ash which is intercalated in the Hodokubo Pumice Bed (Minagawa and Machida, 1971).

e) **Maeganuki Gravel** (Machida, 1986)(Fig. 4-2 and Table 4)

Type locality: Play ground at southeastern margin of the Maeganuki Hills, Hanno City, Saitama Prefecture (Machida, 1986).

Lithofacies: The Maeganuki Gravel was exposed at the southeastern margin of play ground in the Maeganuki Hills but the distribution is sporadical.

The covering volcanic ash (Fig. 4-2) indicated the gravel is contemporaneous with the Odamaki Gravel in the Chichibu Basin (Fig. 4-13) and the Upper part of the Gotentoge Gravel in the Tama Hills.

The Maeganuki Gravel is 3 to 4 m thick and the distribution is restricted. The gravel exists only on the slip side of the confluence along the Iruma and Naruki Rivers and is well preserved from the fluvial erosion. The gravel is rounded and subrounded in cobble to pebble sizes and is mainly composed of sandstone, mudstone, chert and quartz-diorite. The gravel size in the Maeganuki Gravel is a little larger and more angular those in the Hanno Gravel. The weathering of the Maeganuki Hills is more progressed than those of the Hanno Gravel. But the Maeganuki Gravel is difficult to distinguish from the Hanno Gravel in lithofacies

The matrix of the Maeganuki Gravel is tuffaceous sand and silt. The Maeganuki Gravel overlies the Chichibu Palaeozoic System with unconformity.

f) **Tokyo Formation** (Yabe, 1911)(Figs. 4-4, 4-6, 4-7, 4-9, 4-10, 4-12, Tables 4 and Pl. 10, fig. 2)

Type locality: Undecided at the proposal.

Lithofacies: The name of the Tokyo Formation was used for the shell beds in Oji and Tabata (Yabe, 1911) and to the estuarine shell and plant beds in Tabata. The Tokyo Formation is marine deposits at Pleistocene Shimosueyoshi

Transgression and mainly exposed in the Tokorozawa-dai, eastern part of Musashino Plateau (Figs. 4-4, 4-7, 4-9, 4-10 and Pl. 2, fig. 2), and Omiya Plateau (Fig. 4-6). The base of the Tokyo Formation is concealed below the surface of the plain.

Inst. Civil Engin. Tokyo Mtr. Gov. (1996) stated about the type locality of the Tokyo Formation as follows:

"The Tokyo Formation has its stratotype in the drillcore between 9 and 26 m deep, that was bored at municipal Yoyogi Park, Kamizono-cho, Shibuya-ku in 1989. The basal part of the Tokyo Formation consists of sand and gravel beds of about 5 m thick, which includes also round to subround pebbles to cobbles of diameter of 1 to 4 cm with matrix of fine to medium sand. These sand and gravel beds were redefined as the Tokyo Gravel Bed. The whole formation defined as the Tokyo Formation, which is stratified in order of the silt bed (about 2 m thick, *N*-value is 5 to 25) and fine to medium sand (about 10 m thick, *N*-value is 20 to 50), from the Tokyo Gravel Bed upward,"

The Tokyo Formation exposed in the Musashino Plateau consists mainly of muddy sand intercalates thin granule beds. Fossil shells and sandpipes are included in muddy sands along the cliff of the northeastern part of the Musashino Plateau. The Tokyo Formation exposed in the Omiya Plateau (Fig. 4-6) consists mainly of fine and medium grained sands but yields no fossils. It has been known that there are lenses of fossil shell bed within the 10 m deep of the Omiya Plateau in the drilling logs (Fig. 10).

The Tokyo Formation in the Omiya and Musashino Plateaus is gray and bluish gray in color. The Tokyo Formation is covered conformably with the Shimosueyoshi Volcanic Ash Formation, deposited subaqueously in the Omiya Plateau (Kawaguchi Clay; Machida, M., 1973).

g) Kaneko-dai Gravel (Juen, 1966b)(Fig. 4-4, Table 4 and Pl. 7, fig. 1).

Type locality: The type locality of the Kaneko-dai Gravel is proposed herein

at the cliff along the National Highway Route no. 16, Nihongi, Iruma City, Saitama Prefecture (No.7 of Fig. 4-4, Table 4 and Pl. 7, fig. 1).

Lithofacies: The Kaneko-dai Gravel consists mainly of rounded and subrounded cobbles to boulder sized rocks. Sorting of the gravel is common to well. The rocks in the Gravel are sandstone, mudstone, slate and chert, especially many cobble and pebble sized quartz-diorites. The gravels are weathered and converted into spheroidal debris of the Kaneko-dai Gravel. The matrix of the Kaneko-dai Gravel consists of coarse to medium grained sand, tuffaceous sand and volcanic ash.

The covering volcanic ash formation indicates that the Kaneko-dai Gravels is the oldest gravel of the "Shimosueyoshi Terrace" as well as the Tokorozawa-dai Gravel. Typical Shimosueyoshi Terrace emerged at the horizon of the Sanshokuaisu Pumice Bed (abbreviation; SIP)(Fig. 4-12 and Pl. 9, fig. 2) which is intercalated in the lower part of the Shimosueyoshi Volcanic Ash, but in the areas of the Kaneko-dai Gravels at the northwestern part of the Musashino Plateau, there is an air-borne Shimosueyoshi Volcanic Ash of 70 to 100 cm thick below the SIP (Fig. 4-4 and Pl. 7) and the Terrace of Kaneko-dai emerged before deposition of the Shimosueyoshi Volcanic Ash of Shimosueyoshi Plateau.

Machida, M.(1973) reported the above fact mentioned, but no one has reported since then. The Kaneko-dai Gravel has been treated the contemporaneous terrace gravel with the deposit of the Shimosueyoshi Plateau.

Lower limit of the Kaneko-dai Gravel is not exposed on the ground.

h) Tokorozawa-dai Gravel (Oka *et al.*, 1971)(Fig. 4-4, Table 4 and Pl. 7, fig. 2)

Type locality: Cliff behind Kindergarten, Hongo, Tokorozawa City, Saitama Prefecture (No. 9 of Fig. 4-4 and Pl. 7, fig. 2)

Lithofacies: The Tokorozawa-dai Gravel consists mainly of well sorted round to subround sandstone, mudstone and chert in the size of pebble, boulder and cobble. There are tuffaceous clayey boulders in the Tokorozawa-dai Gravel and the diameter of some are 50 cm or more. The matrix of the Tokorozawa-dai

Gravel consists of medium grained sand and changes into tuffaceous sand, silt and clay upward. Relation of the Tokorozawa-dai Gravel and overlying the Shimosueyoshi Volcanic Ash is conformity as that of Kaneko-dai. The thickness is 10 m or less.

i) Konan Gravel (Department of Agriculture and Forestry of Saitama Prefecture, 1968) (No.10 of Fig. 4-6)

Type locality: River side cliff at Honda, Kawamoto Town, Osato-gun, Saitama Prefecture (newly proposed).

Lithofacies: The Konan Gravel (No.10 of Fig. 4-6) exposed along the middle stream of the Arakawa River has been called Konan Gravel for a long time, but its type locality has not been designated.

The gravel is distributed for about 18 kilometers on the south bank of the Arakawa River between Yorii Town and Kumagaya City. The gravel consists mainly of brown to yellowish brown round and subround cobbles of sandstone, mudstone, chert and schist. The gravel along the upper stream of Arakawa River is poorly sorted and comprises many boulders of sandstone, mudstone, chert and schist, but along the down stream of the river it comprises of well sorted pebbles and granules of sandstone, mudstone, chert and shist. The Konan Gravel is 7 to 10 m thick. The matrix of the Konan Gravel is coarse to medium grained sand in Yorii Town along the down stream and becomes coarse to fine grained sand in Kumagaya City along the lower stream where the matrix gradually changes into volcanic ashy sand and clay upward. The Konan Gravel overlies the underlying Miocene Formaition with unconformity at the floor of the Arakawa River between Yorii and Kumagaya.

The overlying layer of the Konan Gravel is the Shimosueyoshi Volcanic Ash deposited subaqueously.

j) Narimasu Gravel (Kobayashi *et al.*, 1968a, b)(Fig. 4-7, Table 4 and Pl. 10, fig. 2)

Type locality: Cliff near Narimasu Kosei Hospital, Zoshiki, Narimasu-machi, Itabashi-ku, Tokyo Metropolis (No. 17 of Fig. 4-7 and Table 4)

Lithofacies: The Narimasu Gravel consists mainly of brown coloured pebbles, sandstone, mudstone and chert. The gravel becomes small in size to eastward along the Kurome River (No.16 of Fig. 4-7). The gravel is pebble to granule in size along the Shirako River. The tuffaceous clay blocks of the boulder size are included in the Narimasu Gravel in places. The matrix of the Narimasu Gravel is coarse to fine grained sand and clay. The grain size becomes small upward and to the eastward. The upper half of the Narimasu Gravel consists mainly of tuffaceous silt and clay in the area close to the Arakawa Lowland.

The Narimasu Gravel is covered by the upper or the upper and middle parts of the Shimosueyoshi Volcanic Ash with conformity (Fig. 4-7). The equivalents to the Narimasu Gravel are extended in distribution over the southern part of the Kanto Region. The Narimasu Gravel in the Musashino Plateau is called as the Hino Gravel in the Hino Plateau, Obara-dai Sand and Gravel in the Miura Peninsula (Hashirimizu Research Group, 1965), Ichikawa Sand (fluvial) in the western part of the Shimosa Plateau (Sugihara. 1970) and the upper part (fluvial) of the Anegasaki Formation in Kiyomi-dai, Kisarazu City (Arai *et al.*, 1977). The distribution of the equivalents to the Narimasu Gravel is discovered by the investigation in the southern part of the Kanto Region. The Narimasu Gravel and its equivalents are in contact with the upper or the upper and middle parts of the Shimosueyoshi Volcanic Ash with conformity.

The thickness of the Narimasu Gravel changes from 4 to 8 m in the Musashino Plateau, 10 to 20 m in Obara-dai and 3 to 5 m in the western part of the Shimosa Plateau.

The Narimasu Gravel was regarded as the Musashino Gravel by Quaternary geologists of the Kanto Region. But the volcanic ash overlying the Narimasu Gravel includes the upper or the upper and middle parts of the Shimosueyoshi Volcanic Ash, therefore, the Musashino Gravel is younger than the Narimasu Gravel. The boundary between the Toshima-dai and Hongo-dai corresponds to

that of the Narimasu and Musashino Gravels at the northeastern margin of the Musashino Plateau. There is difference in height of 5 m between the Narimasu-dai (= Toshima) and Hongo-dai.

k) **Hino Gravel** (Hatori and Juen, 1958)(Fig. 4-8)

Type locality: Exposure along express way of Chuodo, Hino-dai, Hino City, Tokyo Metropolis (Fig. 4-8).

Lithofacies: The Hino Gravel is covered by the Pm-I intercalated in the middle part of the Shimosueyoshi Volcanic Ash (Fig. 4-8). Lithofacies of the Hino Gravel is the same as the Narimasu Gravel, but the grain size of the Hino Gravel is larger than that of the Narimasu Gravel. The Hino Gravel intercalates the layers of sand and clay. The thickness of the Hino Gavel is about 10 m or less.

l) **Musashino Gravel** (Fukuta and Hatori, 1952) (Fig. 4-9, Table 4 and Pl. 10, fig. 2)

Type locality: The cliff at the Hongo-dai, from Azusawa, Itabashi-ku to Akabane, Kita-ku, Tokyo Metropolis (new proposal).

Fukuta and Hatori (1952) reported the Musashino Gravel which is covered by the air-borne Musashino and Tachikawa Volcanic Ashes. But there is probably the Narimasu Gravel instead of the Musashino Gravel covered by the upper or the upper and middle parts of the Shimosueyoshi Volcanic Ash at the type locality along the Kokubunji cliff line between Kamiishiwara and Osawa, Chofu City. There are no outcrops along the cliff at present and the stratigraphic succession cannot be confirmed. The columnar sections in the previous researches do not give a definite statement about the gravel. So the present author defines herein, the Musashino Gravel is covered by only the Musashino and Tachikawa Volcanic Ashes in Hongo-dai.

The Musashino Gravel and its equivalents are distributed in Kawagoe-dai and Hongo-dai in the Musashino Plateau, Sakado and Hanno Cities in the Iruma Plateau, Higashimatsuyama City in the Higashimatsuyama Plateau, Konan

Plateau along the Arakawa River and Kushibiki Plateau. The Musashino Gravel consists of fresh round and subround pebbles of sandstone, mudstone, chert, slate and graywacke with coarse to fine grained matrix. The pebbles of sandstone, mudstone, chert and graywacke at the middle part of the Musashino Plateau become granular eastward in the eastern part of the plateau.

The lower half of the Musashino Gravel consists of granules of chert, sandstone and mudstone, and the upper half of sand and clay at Hongo-dai. The rock fragments composed of the Musashino Gravel are of fresh sandstone, mudstone, graywacke and chert. Lithofacies of the Musashino Gravel resembles that of the Narimasu Gravel, but the grain size of the gravels is a little smaller than those of the Narimasu Gravel. The thickness of the Musashino Gravel is from 3 to 8 m in the Musashino Plateau, but that of the gravel in the Iruma and Kushibiki Plateaus is not clear because the lowest part of it is concealed. Driller's log at Hiramatsu, Hanno City (Asami, 1988) reported the thickness is about 5 m in the Iruma Plateau .

m) Naka-dai Terrace Gravel (Juen, 1966b) (Table 4)

Standard outcrop: Naka-dai (present Wakaba-cho and Irima-cho), Chofu City. The Musashino Volcanic Ash which includes the Tokyo Pumice Bed (Harada, 1943) (abbreviation; TP) overlies the top of the Naka-dai Terrace Gravel. The Naka-dai Terrace Gravel is the youngest gravel in the Musashino Terrace Group which include the Narimasu (=Toshima), Musashino and Naka-dai Terraces. The gravel was not known at the standard outcrop in Naka-dai, Chofu City, because no exposure at present. It is exposed only at the place where the Todoroki Valley joins to the Tama River in the southern part of Setagaya-ku, Tokyo Metropolis. The distribution of the Naka-dai Terrace Gravel is the most small and narrow distribution.

The Naka-dai Terrace Gravel is exposed in the lower stream side cliff of the Todoroki Valley. The difference in heights between the Musashino and Naka-dai Terrace Gravels are about 3 m. The gravel is mainly composed of round to

subround pebbles of chert, sandstone and mudstone. The gravel has no lens of sand or mud that distinguish from the Narimasu and Musashino Gravels. The gravel resembles the Tachikawa and Aoyagi Gravels as stated in the following lines.

n) **Tachikawa Gravel** (Fukuta and Hatori, 1952) (Fig. 4-10, Table 4, Pl. 11, fig. 2 and Pl. 12, fig. 1)

Type locality: Fuchu cliff line in Fuchu City (Fukuta and Hatori, 1952).

The distribution of the Tachikawa Gravel is wide (along the Tama River) in the southern part of the Musashino Plateau but narrow and discontinuous along the Kasumi, Yanase, Kurome and Iruma Rivers, and continuous along the Toshitorazu River. The gravel along the Yanase, Kurome and Iruma Rivers, and in Yorii Town is 2 to 3 m thick and overlies the layers being older than the Tokyo Formation with unconformably.

The gravel consists mainly of boulder and cobble sized rocks in the area between Ome City and Mizuho Town on the west of the Sayama Hills. Its lower part which is probably the basal part of the Tachikawa Gravel (Juen, 1966b and Machida, M.,1973) is in several meters thick and comprises with boulders of sandstone, mudstone, chert, graywacke, slate and quartz-diorite. The gravel about 20 m thick (Ome Sand and Gravel of Juen, 1966b; No.33 of Fig. 4-10 and Pl. 11, fig.2) is existed in the base of the Tachikawa Gravel. The definite unconformity is not recognized in the thick gravel which is thought to be the Tachikawa and much older gravel. There is boulder-sized gravel bed below 15 m from the top of the Tachikawa Gravel, but the unconformity between them was not recognized.

This Tachikawa Gravel is about 20 m thick (includes the Ome Sand and Gravel of Juen) and is composed of cobbles and boulders which were transported from the Kanto Mountains by the old Tama River, and was deposited thickly and built an alluvial fan in the western half of the present Musashino Plateau. The paleo-Tama River was extended eastward and the alluvial fan was prolonged with

the progress of the marine regression. Some parts of the alluvial fan left from the valley was cut down and formed terraces which were called the Tokorozawa Terrace (Figs. 5-2, 5-3 and 6-9). The paleo-Tama River was shifted between the Kaneko-dai and Tokorozawa-dai, and to the south side of the Tokorozawa-dai. The regression was progressed further and the rivers extended eastward, and cut down the river floor. The terraces were successively developed along the paleo-Tama River.

The Tachikawa Gravel is distributed between the terraces which were formed by the Kaneko-dai, Tokorozawa-dai, Narimasu, Musashino and Naka-dai Terrace Gravels along the down streams of the Tama River System. In the eastern part of Ome City which corresponds to the apex of a fan of the Kaneko-dai, the Tachikawa Gravel abutted on the Kaneko-dai Gravel and the distribution in the altitude for both gravels is a few meters, but the difference becomes more than 10 m in the down streams. The difference of altitudal distribution of the Musashino and the Tachikawa Gravels is more than 5 m at Kawagoe-dai along the Arakawa River on the east of the Toshitorazu River, but it decreases to be hardly recognized toward the upper stream of the Toshitorazu River, at the western end of Iruma City on the northwestern margin of the Sayama Hills.

The Tachikawa Gravel is distributed narrowly along the small river of the central part of the studied area and is distributed widely in the Yorii Town and Honjo Plateau in the northern parts of Saitama Prefecture. The Tachikawa Gravel is also distributes in the wide valley floor of the northern part of the Musashino Plateau. The rock fragments were transported into the northern part of Saitama Prefecture by the Kanna, Arakawa and Tone Rivers, because the rocks of crystalline schist and andesite were included in the Tachikawa Gravel. The terrace gravels in the Tokyo Lowland along the down stream of the Arakawa River are of the extension of the Tachikawa Gravel beneath the alluvial plain in the Arakawa Lowland, south of the Yoshimi Hills. The upper part of the Tachikawa Volcanic Ash and the upper part of the alluvial mud and sand overlying the Tachikawa Gravel are concealed under the alluvial plain in the Tokyo Lowland

(Kaizuka, 1979).

The Ekoda Conifer Bed in the Musashino Plateau is classified into six layers of I~VI in descending order. Table 6 shows the plant fossils of theV and VI layers. Kanto Loam

Research Group (1965) reported the ^{14}C age as 28,770±2,600 y. B.P. of the VI layer. This age corresponds to the upper limit of the Tachikawa Gravel. The Tachikawa Gravel is covered with the upper half of the Tachikawa Volcanic Ash.

o) **Aoyagi Gravel** (Fukuta and Hatori, 1952)(Fig. 4-11 and Table 4)

Type locality: Yabo cliff line of the southeast of Aoyagi, Kunitachi City, Tokyo (Fukuta and Hatori, 1952).

The Aoyagi Gravel is narrowly distributed in the lower flat depositional plain of the Tachikawa Gravel along the Tama, Iruma, Arakawa and Kanna Rivers. The Aoyagi Gravel is distributed along the Tama, Iruma, Arakawa and Kanna Rivers. There are no exposures in the Tone River Lowland, east of Kanna River, Arakawa Lowland, south of Kumagaya City and Tama River Lowland, east of Fuchu City. The Aoyagi Gravel is not distributed along the margin of the Tachikawa Gravel in the Musashino Plateau. The Aoyagi Gravel consists of pebbles of sandstone, mudstone, chert, crystalline schist and andesite. The pebble and cobble sized schist and andesite are included in the Aoyagi Gravel along the Arakawa and Kanna Rivers.

The sorting of the Aoyagi Gravel is poorer than that of the Tachikawa Gravel, particularly near the base. The diameter of the gravels is more than 50 cm, but becomes smalles in size upward.

The Aoyagi Gravel is covered by the volcanic ash of the uppermost part of the Tachikawa Volcanic Ash about 50 cm thick (first bed of the Tachikawa Loam Formation proposed by the Kanto Loam Research Group, 1965).

p) **Haijima Gravel**

Typical locality: Along the left bank of the Tama River, Haijima-cho,

Akishima City, Tokyo (Fukuta and Hatori, 1952).

The Haijima Gravel is overlaid by no volcanic ash. The age of the youngest volcanic ash in the Kanto Region is about 10,000 years ago as mentioned by Kaizuka *et al.* (1962). The Haijima Gravel is younger than 10,000 years ago. The gravel beds being equivalents to the Haijima Gravel are distributed along the Iruma and Arakawa Rivers.

The component of the Haijima Gravel is the same as the Aoyagi Gravel, besides the gravel cannot be distinguished in size from the other gravels. The matrix of the gravel is almost lacking. The distribution of the gravel on the ground is not known along the down stream, unlike along the middle and upper streams.

q) Unnamed Terrace Gravel

Among the Holocene formations, the gravel being younger than the Haijima Gravel, is the youngest unnamed terrace gravels .

The unnamed gravel is narrowly distributed in Ome City and is along the main course of Arakawa River in Yorii Town. The gravel consists mainly of pebble to granule sized sandstone, mudstone and chert.

r) Unnamed Alluvial Deposit

The alluvial deposit, with no stratigraphic name, is of deposits forming the present coastal, fluvial and lacustrine plains. Penny *et al.* (1969) and Harmon *et al.* (1979) measured the alluvial deposit in the United States of America respectively, and dated 17,000-18,000 years B.P. At this age, the maximum phase of regression was recorded corresponded to the last glacial age. This is the reason why the alluvial deposits include the late Pleistocene deposites of 17,000 ~ 18,000 years ago.

The alluvial deposits are distributed throughout the Arakawa, Nakagawa and Tokyo Lowlands, and along the valley plain between the plateaus.

The alluvial deposits consist mainly of dark coloured sand, sandy mud and

mud in the Tokyo Lowland. These deposits were called the Yurakucho Formation (Yamakawa, 1909), and are 20 m thick in Urawa and Kawaguchi Cities of the Arakawa Lowland and over 40 m thick in the Tokyo Lowland. These alluvial deposits are the consequent products by the transgression followed the maximum phase of regression of the late Pleistocene. About 6,000 years ago, the maximum phase of transgression (=Yurakucho or Jomon Transgression) was estimated by distribution of shell mounds and marine diatom fossils along the paleo-shoreline of invaded sea into the Arakawa Lowland, the Kawagoe area (Ando and Fujimoto, 1990).

In the eastern part of Higashimatsuyama for the northwestern part of the Arakawa Lowland, the ^{14}C age measurements were reported by a peaty clay layer, 3.4 meters below the ground surface traced from eastern part of Higashi-matsuyama City to Akao, Sakado City, as 3,360±120 y. B.P., and 0.85 meters below the surface as 1,470±95 y. B.P. (Horiguchi *et al.*, 1976). The present author collected the clay for the ^{14}C age measurement at Akao. The result was this age determination was 2,150±80 y. B.P. (Machida, 1995). From these three age determinations, alluvial deposits were deposited during 3,360 to 1,470 years the Arakawa Lowland should be continuous.