

Article

Stratigraphy of the Nishitama Group (Uppermost Permian to Triassic) in the Iwai-Kanyo Area, Southern Kanto Mountains, Japan

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Abstract

The pre-Cretaceous rocks in the Iwai-Kanyo area, southern Kanto Mountains are assignable to the Takamizuyama, Musashi, and Nishitama Groups. The former two groups are composed of the upper Lower to Middle Jurassic sandstone and shale containing exotic blocks of basaltic rocks, limestone, and chert of late Early Carboniferous to Late Triassic age.

The Nishitama Group is a coherent stratigraphic unit composed of six formations: the Oguno (Dorashamian), Iwai (Scythian), Kaizawa (Anisian), Arai (Carnian), Kayakubo (Norian) and Kanyo (Norian possibly ranging up to Lower Jurassic). Among them, the Kaizawa Formation is newly designated herein for the oölitic limestone yielding such diagnostic Anisian foraminifers as *Glomospira densa* and *Meandrosira dinarica* of the Tethyan faunal aspects. These formations are repeated or remain isolated on account of thrust fault structure.

Revised stratigraphy of the Nishitama Group in the Iwai-Kanyo area is described in this paper. Detailed geologic maps, columnar sections, and list of the Anisian foraminifers are presented.

Key Words: Nishitama Group, Iwai-Kanyo area, shelf deposits, Kaizawa Formation, Anisian foraminifers

The Iwai area, northern part of Itsukaichi, southern Kanto Mountains is famous for the occurrence of the Triassic ammonoids and pelecypods. The first report of the fossils, "*Ophiceras*" sp. of Scythian age and "*Pseudomonotis*" *ochotica* of Norian age, dates away back to Fujimoto (1926) and Shimizu (1932). Since these pioneer works, geologic and paleontologic data have been accumulated gradually. Now the Dorashamian (Upper Permian), Anisian and Carnian formations, in addition to the Scythian and Norian ones, are confirmed to be sporadically exposed in the Iwai-Kanyo area. These Permian to Triassic formations, possibly ranging up to the Lower Jurassic, were named as the Nishitama Group by Ozawa and Kobayashi (1986). They are characterized by the occurrence of impure limestone containing detrital quartz grains, sandstone and shale yielding neritic molluscan fossils and plant remains, and intercalation of remarkable intraformational conglomerate sometimes containing acidic to intermediate igneous rock pebbles. These lithologic features are indicative of the shallow shelf facies, and quite different from those of the surrounding formations composed of arenaceous and sheared pelitic rocks of Early to Middle Jurassic age including exotic blocks of basaltic rocks, limestone, and chert.

Through the recent field work in the Iwai-Kanyo area, the Middle Triassic foraminifers were newly found by the first author from the lenticular limestone and conglomeratic limestone both of which were once thought to be referable

to the Oguno Formation or the Arai Formation by Ozawa and Kobayashi (1986). The results force to partly revise the stratigraphy of the Nishitama Group. The purpose of this paper is to describe the revised lithostratigraphy of the Nishitama Group in the Iwai-Kanyo area.

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Geologic Setting

The Iwai-Kanyo area, north of Itsukaichi, is situated in the middle zone of the Chichibu Terrane in the southern part of the Kanto Mountains (Fig. 1). Tectonostratigraphic subdivision in this area is different among authors (Takashima and Koike, 1984; Ozawa and Kobayashi, 1986; Sakai, 1987). Ozawa and Kobayashi (1986) clarified that the complexes in the Itsukaichi district can be subdivided into thrust-bounded three geologic units, on the basis of lithologic assemblages, occurrence and chronologic distribution of exotic blocks, and geologic structure. They are the Musashi, Nishitama and Takamizuyama Groups in tectonically ascending order.

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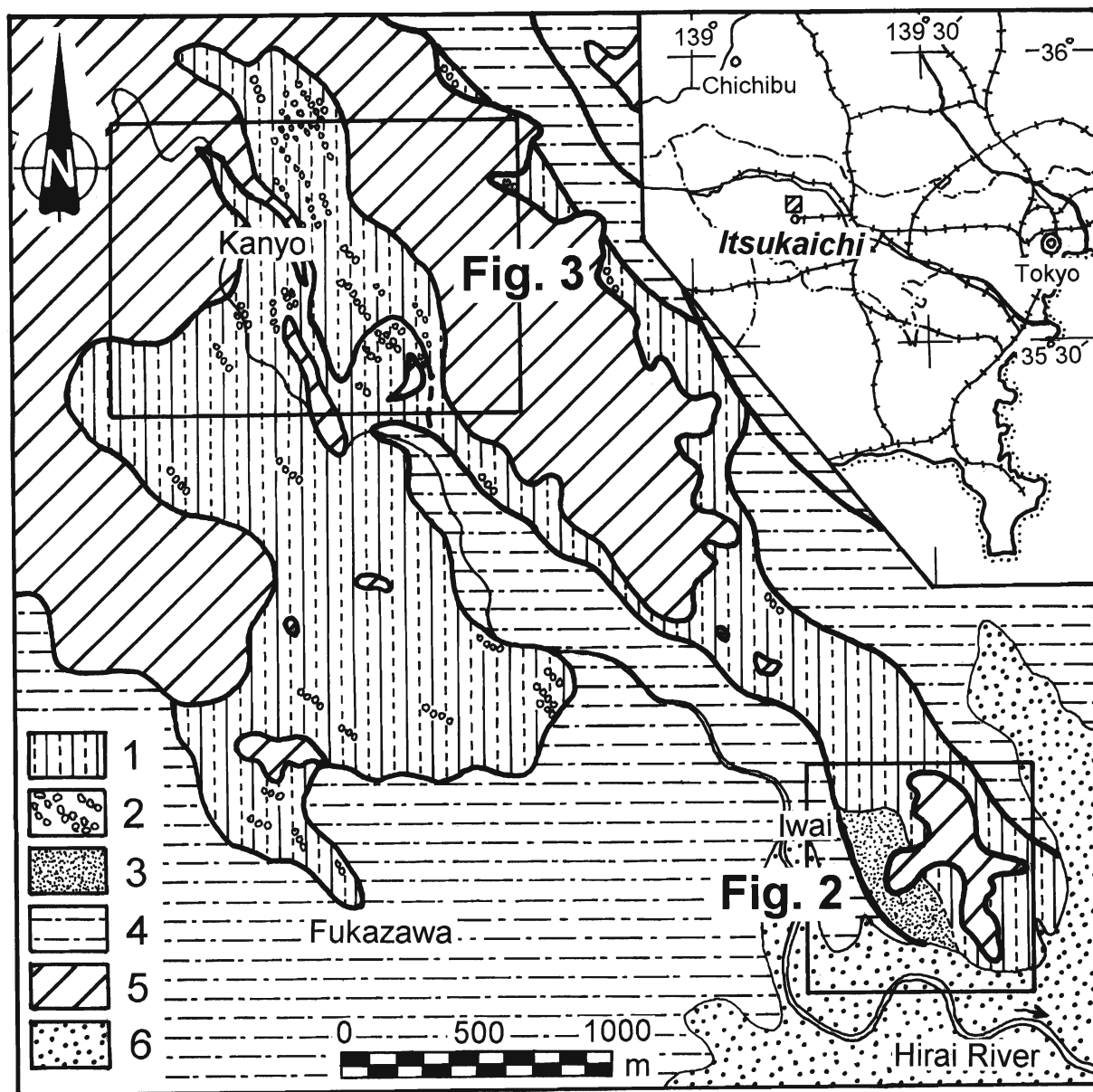


Fig. 1. Geologic map of the Iwai-Kanyo area. 1. Kanyo Formation. 2. conglomerate of the Kanyo Formation. 3. Nishitama Group excluding the Kanyo Formation. 4. Kamiyozawa Formation (Musashi Group). 5. Takamizuyama Group. 6. Tertiary formations.

The Musashi and Nishitama Groups are structurally overlain by a gigantic nappe named the Chichibu Nappe by Ozawa and Kobayashi (1986). The Chichibu Nappe is constructed by four-layered thrust sheets. Each thrust sheet is composed of sets of chert and terrigenous clastic rocks referable to the Takamizuyama Group. The thrust sheet is intensely folded, but the enveloping surface of higher order of the folding is nearly horizontal or gently sloping northward. The Nishitama Group thrusts over the Kamiyozawa Formation (Ozawa and Kobayashi, 1986) of the Musashi Group

in the Iwai area (Fig. 2). The Musashi and Takamizuyama Groups are made up of the upper Lower to Middle Jurassic sandstone and shale, and exotic blocks of basaltic rocks, limestone, and chert, which range in age from late Early Carboniferous to Late Triassic. Huge exotic blocks of bedded cherts of the Takamizuyama Group are well-traceable laterally, and frequently accompany basaltic pyroclastics and lava partly associated with limestone, and alternating beds of chert and limestone or dolostone. Based on these tectonic and lithologic characters, accretionary complexes of the

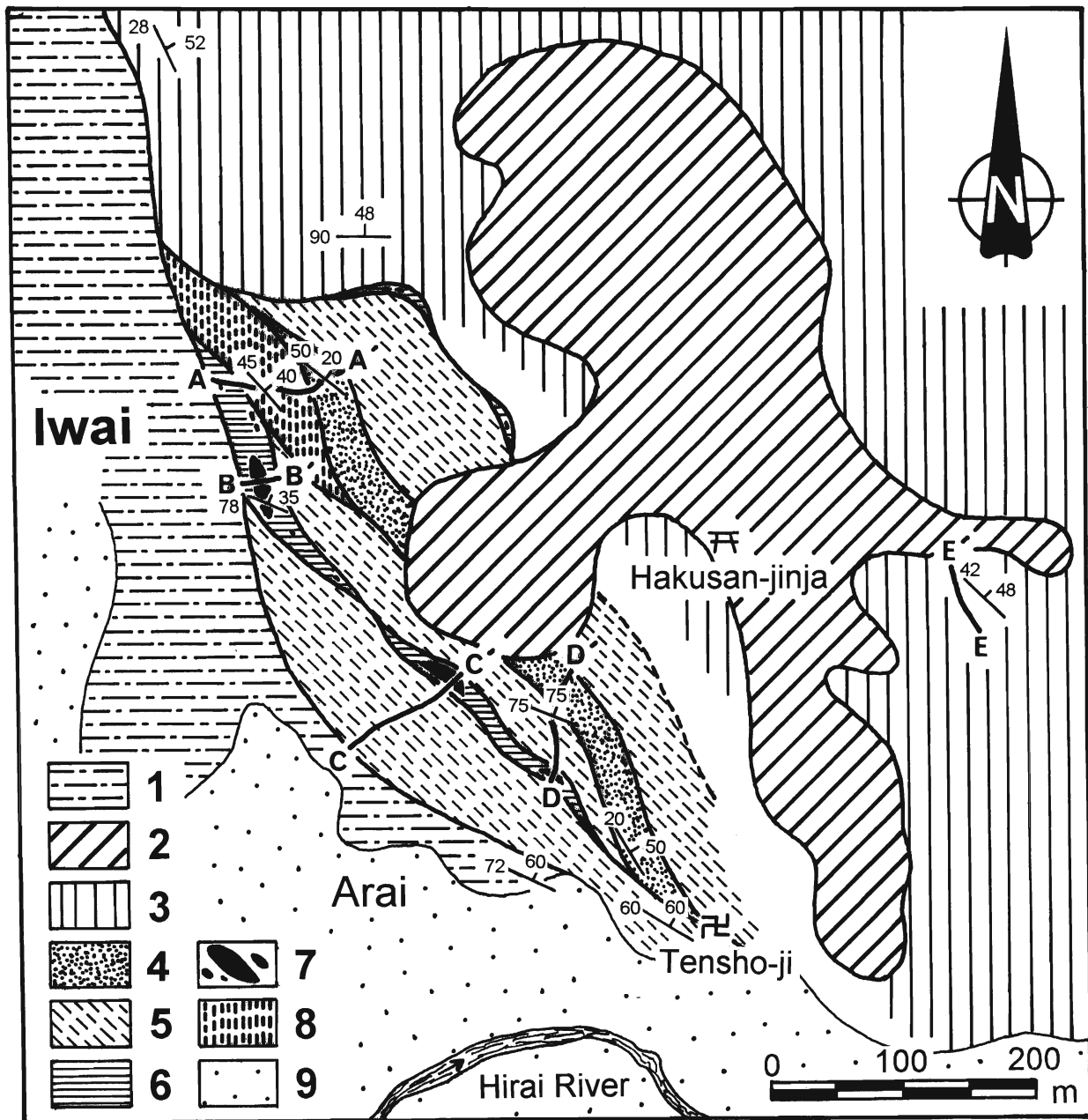


Fig. 2. Geologic map of the Iwai area. 1. Kamiyozawa Formation (Musashi Group). 2. Takamizuyama Group. 3-8. Nishitama Group. 3. Kanyo Formation. 4. Kayakubo Formation. 5. Arai Formation. 6, 7. Kaizawa Formation (6. sandstone and shale, 7. limestone and conglomeratic limestone). 8. Iwai Formation. 9. Tertiary formations.

Takamizuyama Group are easily distinguishable from those of the Musashi Group.

The Nishitama Group was considered to bear originally a coherent stratigraphic unit composed of five formations, in ascending order: the Oguno, Iwai, Arai, Kayakubo and Kanyo in the Iwai-Kanyo area. Ozawa and Kobayashi (1986) once assumed that the younger formation rests unconformably upon the older one. However, recent detailed geologic mapping and age determination by index fossils re-

vealed that these formations are complicatedly rearranged because of thrust faults. For example, the Kaizawa Formation newly proposed in this paper corresponds to a part of the Oguno and Arai Formations described in our previous paper. The Nishitama Group is distributed in the reaches of the Hirai River ranging in altitude from 200 to 450 m where the overlying Chichibu Nappe was eroded out. Detailed geologic mapping also demonstrates that several isolated distributions of chert accompanied by sandstone, shale, basic



Fig. 3. Geologic map of the Kanyo area. Nos. 29 to 33 are fossil localities of the Nishitama Group in the Kanyo area. 1-3. Takamizuyama Group (1. chert, 2. basaltic rocks, 3. sandstone and shale). 4, 5. Kanyo Formation (4. conglomerate, 5. sandstone and shale). 6. Kaizawa Formation. 7. Oguno Formation.

green rocks, tuffaceous limestone and dolostone within the distribution area of the Nishitama Group, are erosional remnants of a thrust sheet composed of the Takamizuyama Group. As already indicated by Zhang (1939), thickly bedded chert with intercalation of the Lower Permian silicified limestone in the Iwai area represents one of such erosional remnants.

Stratigraphy of the Nishitama Group in the Iwai-Kanyo area

Oguno Formation

Designation : The Oguno Formation was proposed by Ozawa and Kobayashi (1986) for the Upper Permian sandstone and calcareous shale with a *Palaeofusulina*-bearing limestone exposed at north of Kanyo, and also for a *Colaniella*-bearing limestone and its correlatable oölitic limestone. Recently, it has become evident that the limestones and surrounding black shale and sandstone exposed at two localities (Locs. 32 and 33 in Fig. 3) are the Upper Permian, but those of others, previously regarded as the Upper Permian, are assignable to the Anisian and referable to the Kaizawa Formation, newly proposed in this paper. The Oguno Formation, therefore, is redefined as follows.

Type area : North of Kanyo (F-F' section in Fig. 3).

Distribution : Sporadically distributed in the type section and H-H' section, east of Kanyo.

Thickness : Estimated to be 10 m.

Lithology : This formation consists mainly of calcareous shale and sandstone with a lenticular limestone of 30 cm thick. The limestone is gray to brownish-gray, highly fossiliferous algal packstone.

Stratigraphic relationship : The lower and upper limits of this formation are in fault contact with the Kanyo Formation and the Takamizuyama Group. Therefore, the original stratigraphic relationship with the Triassic formations of the Nishitama Group as well as the original thickness of this formation is unknown.

Occurrence of fossils and geologic age : Lenticular limestones at Locs. 32 and 33 (Fig. 3) yield a variety of fossils including algae, crinoids, foraminifers, sponges, rugosa corals, ostracods, pelecypods and gastropods. Foraminifer species amounts to 36 including *Palaeofusulina sinensis* Sheng and *Colaniella parva* (Colani). The foraminiferal fauna indicates that this formation is Dorashamian in age.

Iwai Formation

Designation : This formation was originally introduced by Ichikawa and Kudo (1951) for the black shale interbedded with impure limestone containing Scythian ammonoids in and around Kaizawa. Later, Ozawa and Kobayashi (1986)

revised and restrictedly used the Iwai Formation, because of the occurrence of the Upper Permian and Anisian limestones from the distribution area of the Iwai Formation of Ichikawa and Kudo (1951). Recently, it was ascertained that the Anisian oölitic limestone, found within the distribution of the Iwai Formation by Ichikawa and Kudo (1951) and Sakagami (1955), is an erratic derived from the Kaizawa Formation. This Anisian oölitic limestone was formerly assigned to the Arai Formation by Ozawa and Kobayashi (1986). Accordingly, the redefinition of the Iwai Formation is presented as follows.

Type area : Kaizawa (A-A' section in Fig. 2)

Distribution : Only found in the type area.

Thickness : Estimated to be 30 m.

Lithology : This formation is composed mostly of black shale, in which impure lenticular limestones of 15 to 30 cm thick are intercalated in the middle part. These limestones are classified into lime-wackestone, and yield ammonoids and thin-shelled bivalves which are supported by lime-silt matrix. Detrital grains of quartz, mica, iron minerals and carbonaceous materials are intermingled within the silty matrix. The limestone yielding Smithian conodonts (Koike *et al.*, 1985) and thin-shelled bivalves shows parallel lamination and graded bedding.

Stratigraphic relationship : This formation is in fault bounded with the underlying Kaizawa and overlying Kayakubo Formations in the A-A' section.

Occurrence of fossils and geologic age : Impure limestones at Loc. 9 (Figs. 4, 5) have yielded two species of ammonoids; *Owenites shimizui* (Sakagami) and *Dieneroceras iwaiense* (Sakagami) (Sakagami, 1955; Kummel and Sakagami, 1960), and three species of conodonts, *Furnishius tricerratus* Clark, *Ellisonia triassica* Muller and *Neospathodus waageni* Sweet (Koike *et al.*, 1985). Sakagami (1955) once reported *Aspenites* sp. from the upper part of this formation (Fig. 5), although the exposure of this locality (Loc. 8 in Fig. 4) is now covered with talus deposits. This formation is considered to be of Smithian Age (Scythian Epoch) as determined from ammonoids and conodonts.

Kaizawa Formation

Designation : This formation is newly proposed by Kobayashi and Ozawa (this paper) for the Anisian limestone and conglomeratic limestone, and the surrounding sandstone and shale.

Etymology : The formation name is derived from a small valley locally called as "Kaizawa", running E-W in the east of Iwai. Although the Kaizawa does not fulfill the rule of naming of lithostratigraphic unit, the name is used herein on account of lack of other acceptable geographic names where this unit is typically developed.

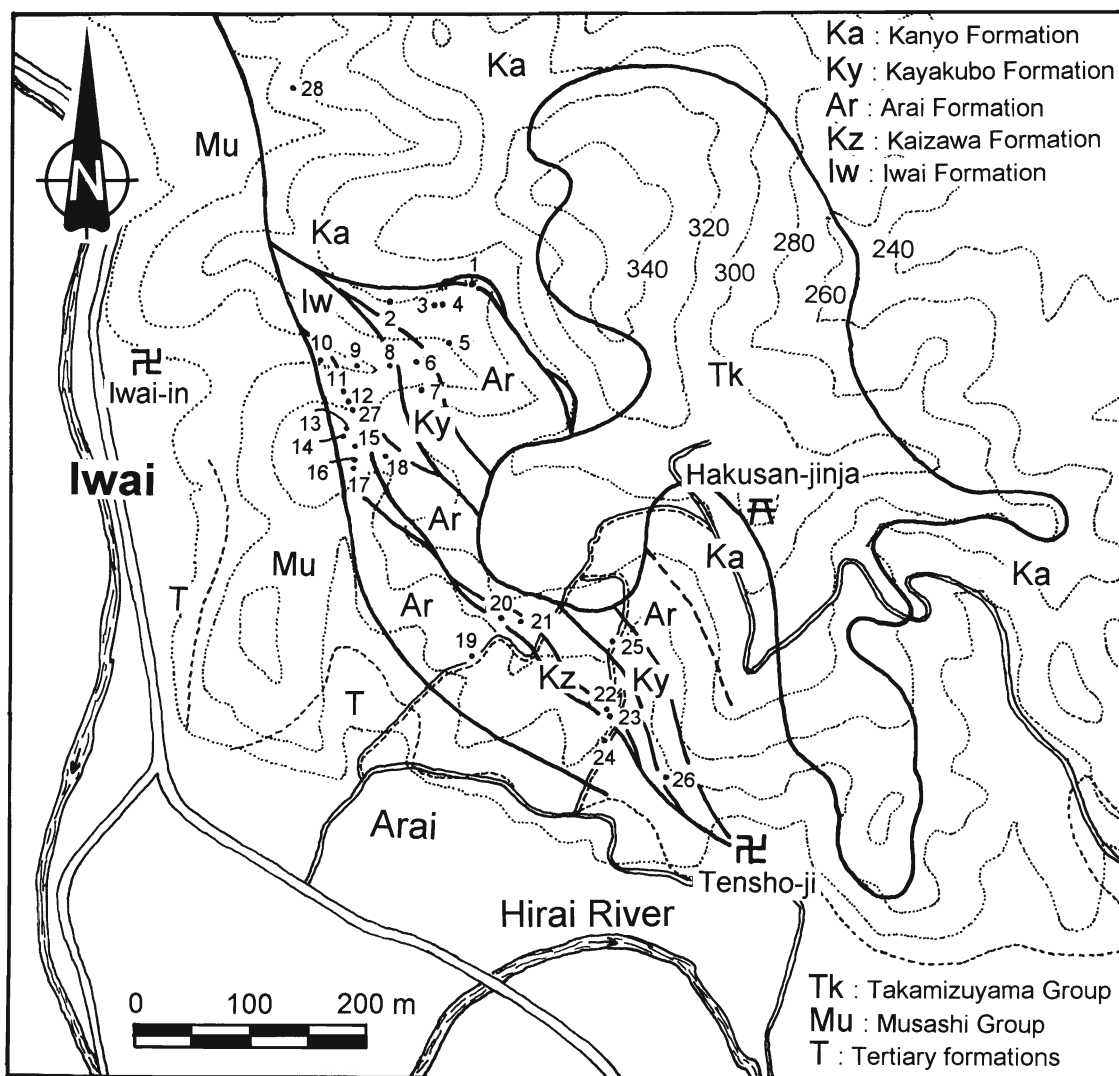


Fig. 4. Fossil localities of the Nishitama Group in the Iwai area. Nos. 2-5, 18, 19, 24 and 28 are adopted from Ichikawa and Kudo (1951), and No. 8 is from Sakagami (1955).

Type area : South of Kaizawa (B-B' section)

Distribution : This formation is distributed from Kaizawa to Arai trending NW to SE, and discontinuously exposed along the fault demarcating the Arai and Kanyo Formations in the Iwai area (Fig. 2). It is also exposed in west side on the halfway up the ridge, 300 m east of Kanyo (G-G' section in Fig. 3).

Thickness : About 22 m in the type section, and more than 20 m in east of Kanyo.

Lithology : This formation shows a considerable lateral change in lithofacies (Fig. 5). It is made up of black shale and sandstone with intercalation of lenticular limestone and

conglomeratic limestone of less than 30 cm thick in A-A' section and northeast and east of A-A' section; highly conglomeratic limestone of 50 to 150 cm thick and sandstone in the midway between A-A' and B-B' sections; dominant massive limestone of 5 to 11 m thick partly interlaminated with fine-grained sandstone to siltstone and partly conglomeratic in B-B' and D-D' sections; and massive limestone of 10 to 20 m thick in C-C' and G-G' sections.

The massive limestones are made up of oöid grainstone cemented with sparry calcite. Most of pebbles to cobbles within conglomeratic limestone are also oölitic grainstone. They contain numerous well-sorted quartz grains both in the

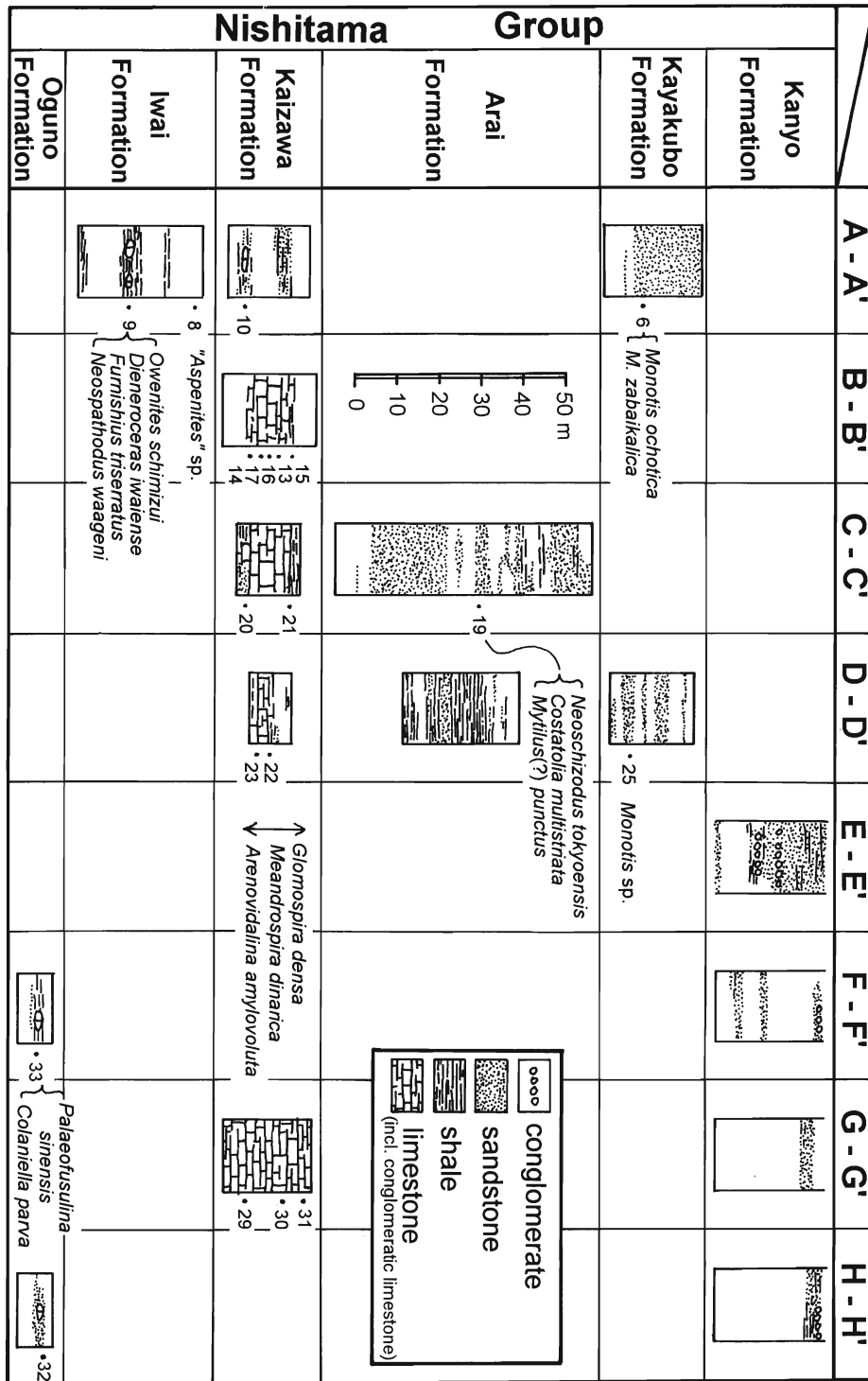


Fig. 5. Columnar sections of the Nishitama Group in the Iwai-Kanyo area. Location of each column is shown in Figs. 2 and 3.

matrix and nucleus of oöids. Pebbles to cobbles of algal grainstone and algal packstone of Anisian age are also found in the conglomeratic limestone. Pre-Triassic pebbles to cobbles are restricted to Dorashamian in age. They are gray to light gray in color and mostly of algal grainstone. Quartz grains are also included in both the Dorashamian and Anisian pebbles to cobbles. Massive oölitic limestone is partly invaded by undulated seams composed of lime-wackestone, and grades laterally and vertically into micaceous sandstone, gradually decreasing oöids content.

Stratigraphic relationship : In the Iwai area, the lower limit of this formation is in fault bounded with the Arai Formation. The upper limit of this formation is also in fault contact with the Iwai Formation in Kaizawa, and with the Arai Formation in north of Arai.

Occurrence of fossils and geologic age : The age of this formation is determined by the occurrence of Anisian foraminifers having an intimate Tethyan faunal affinity as listed in Table 1, and also by the occurrence of Anisian conodont, *Neogondolella bulgarica* (Budrov and Stefanov). Among the foraminifers, the occurrence of *Glomospira densa* (Pantić) and *Meandrospira dinarica* Kochansky-Devidé and Pantić is noteworthy. They are important in-

dex species restricted to the Anisian of the Muschelkalk and its contemporaneous limestones in Europe to West Asia (e.g. Premoli Silva, 1971; Zaninetti, 1976; Trifonova, 1978). Pebbles of algal grainstone and algal packstone are especially fossiliferous, and yield algae, bryozoans, sponges, crinoids, pelecypods, gastropods, and ostracods in addition to the foraminifers and the conodonts. Massive limestone and pebbles to cobbles of oöid grainstone also contain bioclasts of these fossils.

Arai Formation

Designation : Ichikawa and Kudo (1951) proposed the Arai Formation for the Middle to Upper Triassic bluish sandstone typically exposed along the path from Arai to Hakusanjinja. Ozawa and Kobayashi (1986) added the "Halobia-bearing Formation" (Ichikawa and Kudo, 1951) in the Iwai area and the Tachigaya Formation (Ozawa and Hayami, 1969) in west of Ome to this formation. The Arai Formation in this paper corresponds to that defined by Ozawa and Kobayashi (1986) with the exception of the Anisian oölitic limestone newly assigned to the Kaizawa Formation as described above.

Table 1. Anisian foraminifers from the Kaizawa Formation. Locality numbers correspond to those in Figs. 2 and 3.

	1	10	11	12	13	14	15	16	17	20	21	22	23	27	29	30	31
<i>Ammodiscus</i> sp.		×												×			
<i>Glomospira densa</i>	×	×		×	×	?	×			×	×		×	×	×	×	×
<i>Glomospira</i> sp.		×		×											×	×	
<i>Glomospirella irregularis</i>		?		×										×			
<i>Rectoglomospirella</i> sp.	×																
<i>Malayspirina</i> cf. <i>fontainei</i>		×		×										×			
<i>Duotaxis</i> sp.		?		×													
<i>Gaudryina</i> cf. <i>triadica</i>		×	?	×									?				
" <i>Endothyra</i> " cf. <i>kuepperi</i>		×		×		?								×			
Endothyridae gen. et sp. indet.		×		×													
<i>Triadodiscus</i> sp.	×																
<i>Triadodiscus</i> ? sp.	×										×						
<i>Arenovidalina amylovoluta</i>	×	×	×				×	×	×	×	×	×	×		×		
<i>Arenovidalina</i> sp.	?	×		?				×		×							×
<i>Aulotortus</i> ? sp.	×																
Involutinidae gen. et sp. indet.	×									?				×	×		
<i>Meandrospira dinarica</i>	×	×	×	×	?								×	×	×		
" <i>Meandrospira</i> " <i>deformata</i>		×		×						×							
<i>Austrocolomia</i> cf. <i>marschalli</i>		×															
<i>Austrocolomia</i> sp.		×									×						
<i>Cryptoseptida</i> ? sp.		×		×													
<i>Nodosaria expolita</i>			×	×													
<i>Nodosaria</i> spp.			×	×										×			
<i>Diplotremina astrofimbriata</i>	×			×	×									×			
<i>Diplotremina</i> sp.														×			

Type area : Along the path from Arai to Hakusan-jinja (C-C' section).

Distribution : This formation is distributed separately in three zones trending NW to SE in the Iwai area (Fig. 3).

Thickness : About 60 m in the type section, and less than 60 m in other sections.

Lithology : This formation is composed of greenish massive sandstone partly interbedded with black calcareous shale in the type section, and of sandstone and shale with intercalation of granule conglomerate in D-D' section (Fig. 5).

Stratigraphic relationship : In the type area, this formation thrusts over the Kamiyozawa Formation of the Musashi Group, and is in fault contact with the Kaizawa Formation (Fig. 2). In D-D' section, this formation rests upon the Kaizawa Formation and is overlain by the Kayakubo Formation.

Occurrence of fossils and geologic age : Paleontologic works of the molluscan fauna of this formation were carried out by Ichikawa (1954a, 1954b) in which Carnian age of the fauna was clarified. The following species were described [some of generic names revised after Hayami, 1975] : *Bakevella araiensis* (Ichikawa), *Gervillia (Cultrioopsis) hosonaga* Kobayashi and Ichikawa, *Myoconcha planata* Kobayashi and Ichikawa and other seven species from Loc. 18 (Fig. 4), and *Mytilus(?) punctus* Ichikawa, *Neoschizodus tokyoensis* (Ichikawa), *Costatolia multistriata* (Kobayashi and Ichikawa) and other four species from Loc. 19 ; *Neoschizodus* sp. from Loc. 2, *Paleoneilo iwaiensis* Ichikawa, *Halobia* sp. and other four species from Loc. 3, *Trigonucula sakawana inequilatera* Ichikawa from Loc. 4, and *Halobia molukkana* Wanner and other three species from Loc. 5. In addition, Ozawa and Hayami (1969) reported such Carnian bivalves as *Oxytoma mojsisovicsi* (Teller), *Pseudolimea naumanni* (Kobayashi and Ichikawa) from Tachigaya, west of Ome.

Kayakubo Formation

Designation : Ichikawa and Kudo (1951) called the "Entomonotis-bearing Formation" for the *Monotis*-bearing sandstone typically developed in Kaizawa ("M Valley" in Ichikawa and Kudo, 1951). Later, this lithostratigraphic unit was designated as the Kayakubo Formation by Ozawa and Kobayashi (1986).

Type area : Kaizawa (A-A' section)

Distribution : The Kayakubo Formation is traceable from Kaizawa to Tensho-ji trending NW to SE, although it is partly covered with a thrust sheet of the Takamizuyama Group.

Thickness : 22 m

Lithology : This formation is characterized by greenish gray, massive, micaceous, medium- to fine-grained

arkose sandstone yielding abundant *Monotis ochotica* with interbeds of coarse-grained sandstone and black shale partly yielding abundant plant remains.

Stratigraphic relationship : Lower and upper limits of this formation are in fault contact with the Iwai and Arai Formations, respectively, in the type section.

Occurrence of fossils and geologic age : *Monotis ochotica* Kaiserling, *M. zabaikalica* (Kiparisova) and some other molluscan and brachiopod species occur from the sandstone at Locs. 6, 7, 25 and 26 (Ichikawa, 1951). The formation is assignable to the Norian based on the fossil assemblages.

Kanyo Formation

This formation, designated by Ozawa and Kobayashi (1986), is most extensively distributed among the six formations of the Nishitama Group in the northern part of Itsukaichi. Lithostratigraphic description of this formation was closely given by Kobayashi (1993). The Kanyo Formation is composed mainly of massive sandstone, black shale and alternating beds of sandstone and shale, with intercalations of remarkable intraformational conglomerate. This formation attains about 210 m in thickness in the type area (B-B' section in Fig. 1 of Kobayashi, 1993), and is estimated to be 250 m in its maximum thickness in other sections in north of Itsukaichi.

The layers of conglomerate occur at two to four horizons. They vary in thickness from several tens cm to more than 10 m, and rather abruptly shifts laterally into sandstone or black shale. The conglomerate is ill-sorted, and mostly made up of subrounded to subangular pebbles to cobbles of abundant limestone and subordinate chert, sandstone, mudstone and basaltic rocks with minor amounts of granite, granodiorite, porphyrite and andesite. Roundness, diameter and lithologic composition of the conglomerate considerably vary from place to place. The limestone conglomerate of this formation yields 52 species of Moscovian to Artinskian foraminifers (Kobayashi, 1993).

The Kanyo Formation is underlain by the Oguno Formation in the type section, and by the sandstone probably referable to the Kayakubo Formation in the Iwai area. Stratigraphic relationship between them is still confidently undetermined, but they are probably fault-bounded each other. The micaceous fine-grained sandstone yields a fragment of *Monotis* ? sp. (Zhang, 1939 ; Ichikawa and Kudo, 1951) at Loc. 28 shown in Fig. 4. *Monotis ochotica* Kaiserling was reported by Takagi (1944) from the sandstone referable to this formation in west of Ome. Although the age of this formation has not yet been exactly determined in the type area, it is considered to be Late Triassic, and possibly ranging up to Early Jurassic in age.

Concluding Remarks

As mentioned above, the Nishitama Group is characterized by the occurrences of impure bioclastic limestones containing detrital quartz grains, sandstone and shale yielding abundant neritic molluscs and plant remains, and remarkable intraformational conglomerate. Basaltic rocks and chert are completely lacking. These lithologic features are indicative that the Nishitama Group is originated in shallow shelf facies on an island arc or a continent, and are quite different from those of the neighboring Takamizuyama and Musashi Groups. Lithostratigraphy and fossil contents of the Nishitama Group are important concerning not only the regional geology in this area but also the eastern extension of the Kurosegawa Belt in relation to juxtaposition of the Japanese pre-Cretaceous accretionary complexes, and others. They are further connected with the Late Permian to Triassic paleobiogeography of the Tethys.

Preceding the discussion of these problems, revised stratigraphy of the Nishitama Group in the Iwai-Kanyo area is described in detail with geologic maps and columnar sections.

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