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The Triassic Tandodani Formation in the Hongo area, Hida Gaien belt, central Japan

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ABSTRACT

The Triassic Tandodani Formation in the Hongo area, Hida Gaien belt, central Japan is newly defined and described. The formation is divided into the Lower and Upper Members. The former is composed mainly of tuffaceous clastic rocks with minor amount of felsic tuff intercalations, while the latter is mainly felsic tuff, and alternating beds of felsic tuff and tuffaceous mudstone. The Upper Member yields late Triassic conodonts (Tsukada et al., 1997) and, at its upper limit, is in fault contact with the Carboniferous Arakigawa Formation.

INTRODUCTION

The Hida Gaien belt (the Hida marginal belt of Tsukada, 2003) is a major tectonic belt of SW Japan and was formed through Jurassic dextral and Cretaceous sinistral movements that affected the 'proto-Hida Gaien belt' ('the proto-Hida marginal belt'; Tsukada, 2003). The Hida Gaien belt is composed mainly of Paleozoic shelf facies rocks and post-Jurassic rocks. Although some theories to explain the Paleozoic history of the proto-Hida Gaien belt have been proposed, on the basis of detailed lithostratigraphical and paleontological studies (e.g. Fujimoto et al., 1962; Tazawa, 1993), the Mesozoic, particularly Triassic, history of the belt still remains unclear. Triassic conodonts have recently been reported from the Hongo area of the Hida Gaien belt (Tsukada, 1997), but the detailed lithostratigraphy and structure of the Triassic strata, both of which are critical to our understanding of the development of the belt, have not until now been revealed. This paper describes the lithology, stratigraphy, and geological structure of the Triassic strata of the Hongo area, the only one fossil-bearing Triassic geologic unit in the Hida Gaien belt, and defines the strata as the Tandodani Formation.

GEOLOGICAL OUTLINE OF THE HONGO AREA

In the Hongo area, Kamitakara-cho, Takayama City, central Japan, the Carboniferous Arakigawa, the Permian Moribu and the Triassic Tandodani Formations are narrowly exposed (Figs. 1 and 2). The Arakigawa Formation is unconformably overlain by

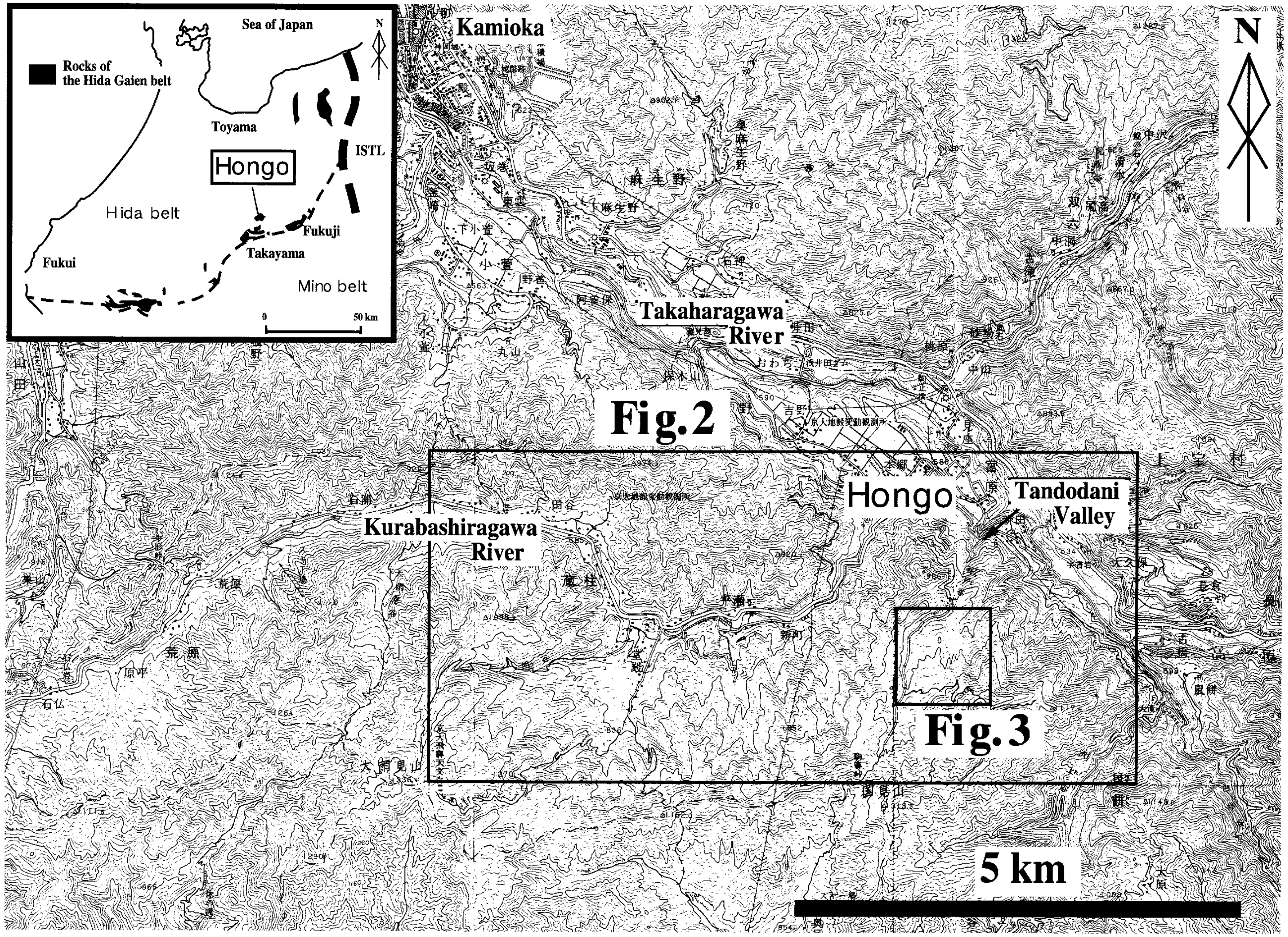

Fig. 1. (a) Index map. (b) Topographic map of the Hongo area, Gifu Prefecture, central Japan. The topographic map is part of the 1:50,000 scale map sheet "Funatsu" published by the Geographical Survey Institute of Japan. ISTL: Itoigawa–Shizuoka tectonic line.

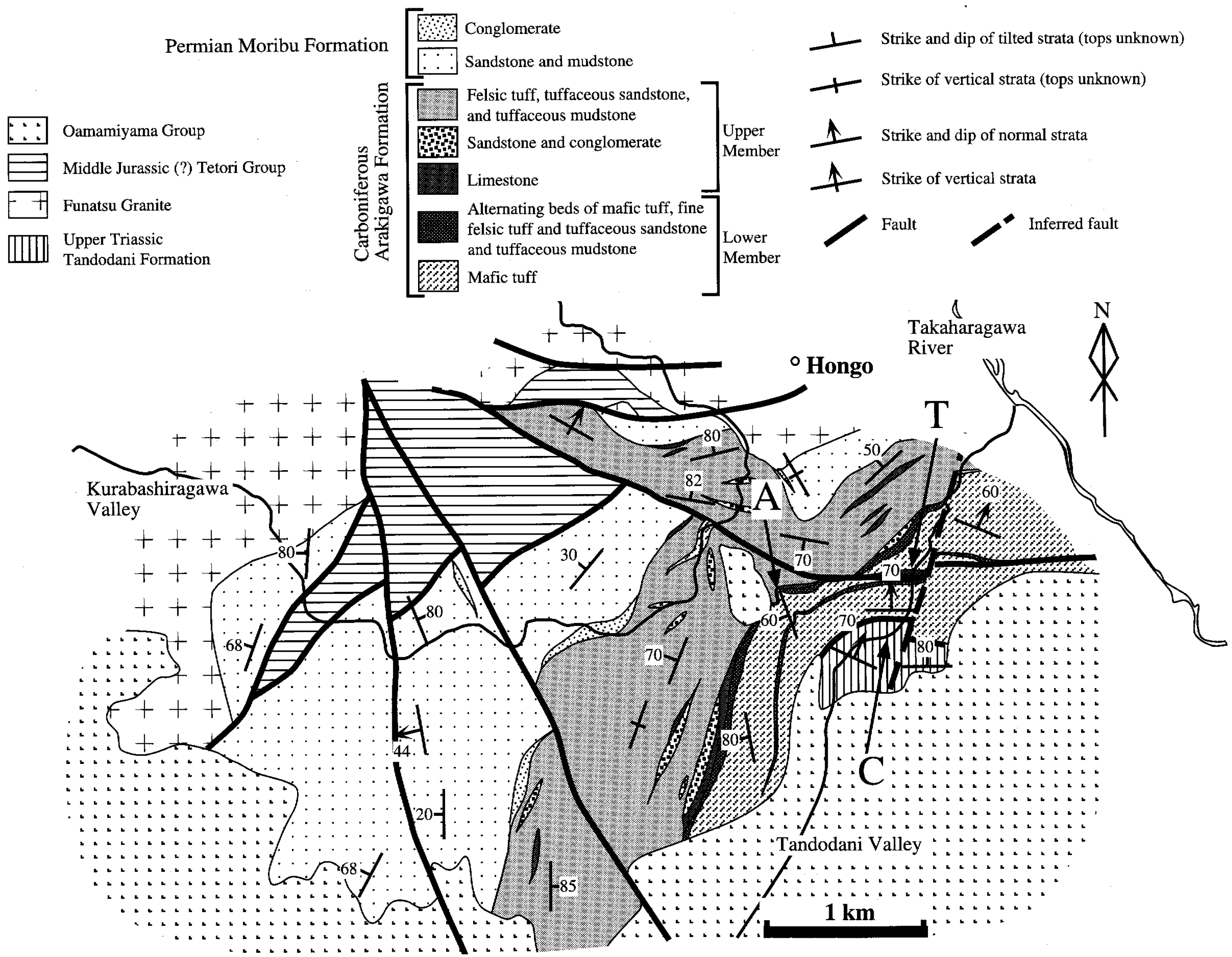

Fig. 2. Geological map of the Hongo area. See Fig. 1 for the location.
T: Carboniferous trilobite locality (Kobayashi and Hamada, 1987), A: Carboniferous ammonoid locality (Igo, 1964), C: Triassic conodont locality (Tsukada et al., 1997)

the Moribu Formation (Horikoshi et al., 1987; Niwa et al., 2004), and the Tandodani Formation, which is newly described in this paper, structurally underlies the Arakigawa Formation with a shear zone in this area. The Funatsu Granite has cut and baked the Arakigawa and Moribu Formations in the northern part of the Hongo area, but its relation with the Tandodani Formation is still unknown. K–Ar whole-rock age of 149±5 Ma from the biotite hornfels of the Moribu Formation (Adachi and Shibata, 1991) probably show the intrusion age of the granite. The shear zone between the Tandodani and Arakigawa Formations was likely formed coevally with dextral shear zones in the Funatsu Granite (Otoh et al., 2003), and hence is younger than the Funatsu Granite. All the formations and shear zone, mentioned above, are folded around the axis of an anticline, which plunges steeply northwest; i.e. the formations trend eastward and dip steeply northward in the northeastern limb of the anticline, but trend northward and dip steeply westward in the southwestern limb. The Middle Jurassic (?) Tetori Group unconformably overlies the Funatsu Granite. The uppermost Cretaceous to Tertiary Oamamiyama Formation (Kasahara, 1979) unconformably covers all the pre-Cretaceous rocks of the area, and all of these rocks are cut by some younger subvertical faults (Fig. 2).

***The Arakigawa Formation* (Isomo and Nozawa, 1957)**

The Arakigawa Formation can be divided into the Lower and Upper Members (Fig. 2). The Lower Member is composed mainly of mafic tuff and partly of alternating beds of mafic tuff, fine felsic tuff and tuffaceous clastic rocks. The mafic tuff is so altered that most of the mafic minerals, except for clinopyroxene, have been changed to secondary minerals such as chlorite. In some places the tuff includes abundant crinoid stems. The Upper Member is composed mainly of felsic tuff and tuffaceous clastic rocks with minor intercalations of conglomerate, sandstone and limestone. The felsic tuff, the tuffaceous clastic rocks and the limestone are thermally metamorphosed and strongly recrystallized in the northern part of the Hongo area. The trilobite (*Paladin hidensis*) and the ammonoid (*Goniatites* sp.), both of Carboniferous age, have been found in the Lower Member (Kobayashi and Hamada, 1987; Igo, 1964). In addition, Late Visean to late Kasimovian (or Gzhelian?) fossils such as corals, smaller foraminifers, fusulinoideans and brachiopods have been found in the same formation in the neighbouring Moribu area which lies 1.5 km to the southwest of Hongo (Isomi and Nozawa, 1957; Fujimoto et al., 1962; Tazawa et al., 2000).

***The Moribu Formation* (Isomo and Nozawa, 1957)**

The Moribu Formation is composed largely of sandstone and mudstone with a minor amount of felsic tuff, tuffaceous clastic rocks, conglomerate, and limestone in its lower horizon. Although fossils have not been reported from this formation in the Hongo area, early Permian brachiopods and fusulinoideans have been found in it in the Moribu area (Horikoshi et al., 1987; Tazawa et al., 1993; Niwa et al., 2004; Yamada and Yamano, 1980).

The Tandodani Formation

The Tandodani Formation (see definition below) is composed mainly of felsic tuff and tuffaceous clastic rocks. The Carnian to Norian conodonts such as *Epigondolella abneptis* have been reported from finely laminated felsic tuff and tuffaceous mudstone of this formation (Tsukada et al., 1997).

TANDODANI FORMATION (NEWLY NAMED)

Definition: The Triassic strata composed mainly of felsic tuff and tuffaceous clastic rocks around the upper stream of the Tandodani Valley in the Hongo area, Kamitakara-cho, Takayama City, Gifu Prefecture, central Japan are newly designated as the Tandodani Formation. Although these rocks have previously been included in the Arakigawa Formation (Isomi and Nozawa, 1957), they should be distinguished from it as a separate formation. The reasons are as follows; (1) the two formations are in fault contact with each other, (2) the Tandodani Formation yields Triassic conodonts, while the Arakigawa Formation yields Carboniferous fossils such as corals, ammonoids and trilobites.

Type locality: The type section is exposed beside the forestry road along the Tandodani Valley (at an elevation of 910 m to 930 m, Fig. 3). Reference sections

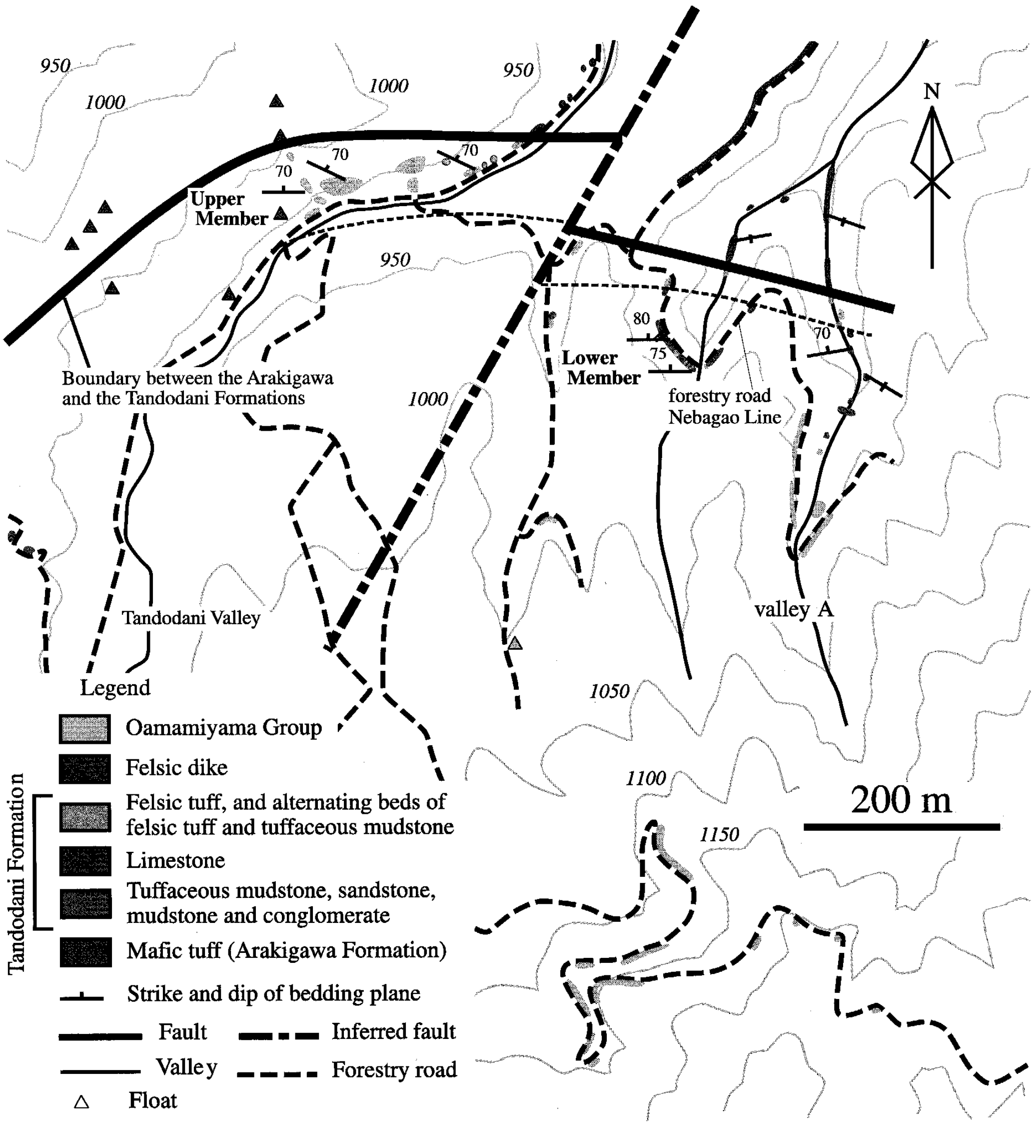

Fig. 3. Route map of the upper stream of the Tandodani Valley. See Fig. 1 for the location.

are exposed in the upper stream of the valley A on Fig. 3 (elevation 880 to 940 m) and along the forestry road Nebagao Line (Fig. 3). The boundary stratotype section between the Arakigawa and Tandodani Formations is exposed in the forestry road along the Tandodani Valley (elevation 910 m).

Distribution: This formation is exposed in the area of the upper stream of the Tandodani Valley.

Thickness: This formation is more than 200 m in thickness.

Stratigraphy and structure: This formation can be divided into the following two members in ascending order: (1) the Lower Member composed mainly of tuffaceous clastic rocks with minor amount of felsic tuff intercalations, and (2) the Upper Member composed mainly of felsic tuff (Figs. 3 and 4). Characteristic conglomerates are

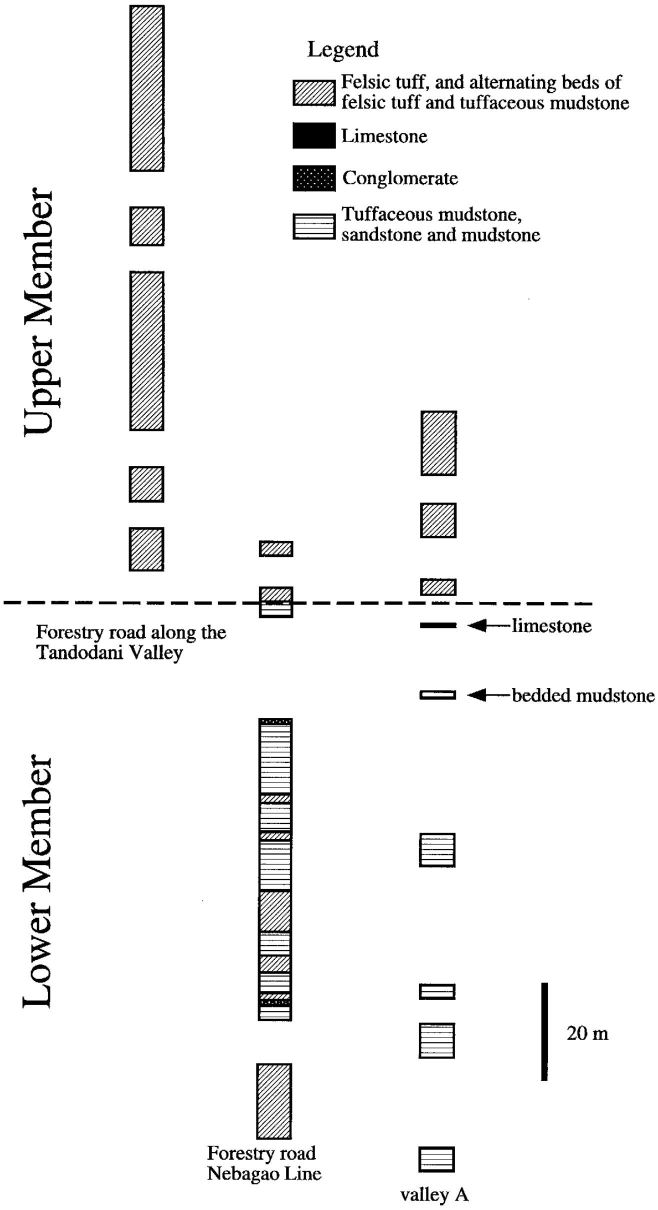

Fig. 4. Columnar sections of the Tandodani Formation.

intercalated in the Lower Member.

The formation occurs only in the northeastern limb of the anticline in the Hongo area and hence forms an east-trending and north-dipping homocline. The upper limit of the formation is bounded by the Arakigawa Formation with a shear zone (Figs. 2 and 3). The boundary plane trends eastward and dips steeply northward. The formation, as well as the Paleozoic formations in the Hongo area, is unconformably overlain by the uppermost Cretaceous to Tertiary Oamamiyama Group.

Boundary between the Tandodani and the Arakigawa Formations: A shear zone occurs in the boundary between the Tandodani and Arakigawa Formations. The shear zone is composed mainly of foliated cataclasite derived from mafic tuff and felsic tuffaceous clastic rocks, and has east-trending and steeply north-dipping foliation and subhorizontal lineation on it. The foliation in the shear zone is mainly defined by dimensional preferred orientation of micas. Microscopic observation reveals various kinds of shear sense indicators which show a dextral sense of shear such as Riedel shear of R1-type (Logan et al., 1979), P-Y fabric (Rutter et. al., 1986). Asymmetrically elongated grains are commonly observed in the foliated cataclasite.

Occurrence and lithology:

Lower Member: Alternating beds of tufffaceous sandstone and tufffaceous mudstone with felsic tuff and tuff breccia intercalations are the major rock types of this member. The alternating beds exhibit graded bedding indicating northward facing; the thickness of each bed ranges from a few cm to 20 cm (Fig. 5a). The tuffaceous mudstone of this member has many sporadic inclusions of felsic volcanic rock fragments and also euhedral plagioclase crystals. It is characteristically dark reddish grey or dark purple (Fig. 5b). The felsic tuff consists mainly of felsic volcanic rock fragments, plagioclase, quartz and opaque minerals. It is often very fine and well laminated. The laminated felsic tuff exhibits graded bedding indicating northward facing; each lamina is from a few mm to 1 cm thick. The tuff breccia includes many granule- to pebble-sized felsic volcanic rock fragments in a matrix of felsic tuff (Fig. 5c). Both the felsic tuff and the tuff breccia are pale green. Rarely intercalated within this member are layers of sandstone and conglomerate which are up to several tens centimeters in thickness. The sandstone is grey lithic wacke and includes many fragments of intermediate to felsic volcanic rocks, sandstone, and mudstone. It also includes plagioclase, quartz and secondary minerals such as chlorite and calcite. These fragments and grains are only weakly rounded. A thick layer of poorly-sorted conglomerate, which occasionally includes cobble-sized clasts, lies in the upper part of this member. The conglomerate is clast-supported and includes many sub-angular to sub-rounded clasts of intermediate to felsic volcanic rocks, sandstone and mudstone. This member has well-bedded black mudstone and a gray limestone lens. Each bed of the bedded mudstone is from 1 to 5 cm thick. The limestone is mainly micrite (*sensu* Folk, 1959) which is partly recrystallized or deformed into foliated cataclasite.

Upper Member: This Member consists mainly of felsic tuff, and alternating beds of felsic tuff and tuffaceous mudstone. The tuffaceous mudstone is much smaller in amount than the felsic tuff. The rocks are mainly well-bedded or laminated (Fig. 5d). Where the rocks are, the bedding is graded indicating northward facing and each bed is from 1 to 10 cm thick (Fig. 5e). The felsic tuff is composed mainly of felsic

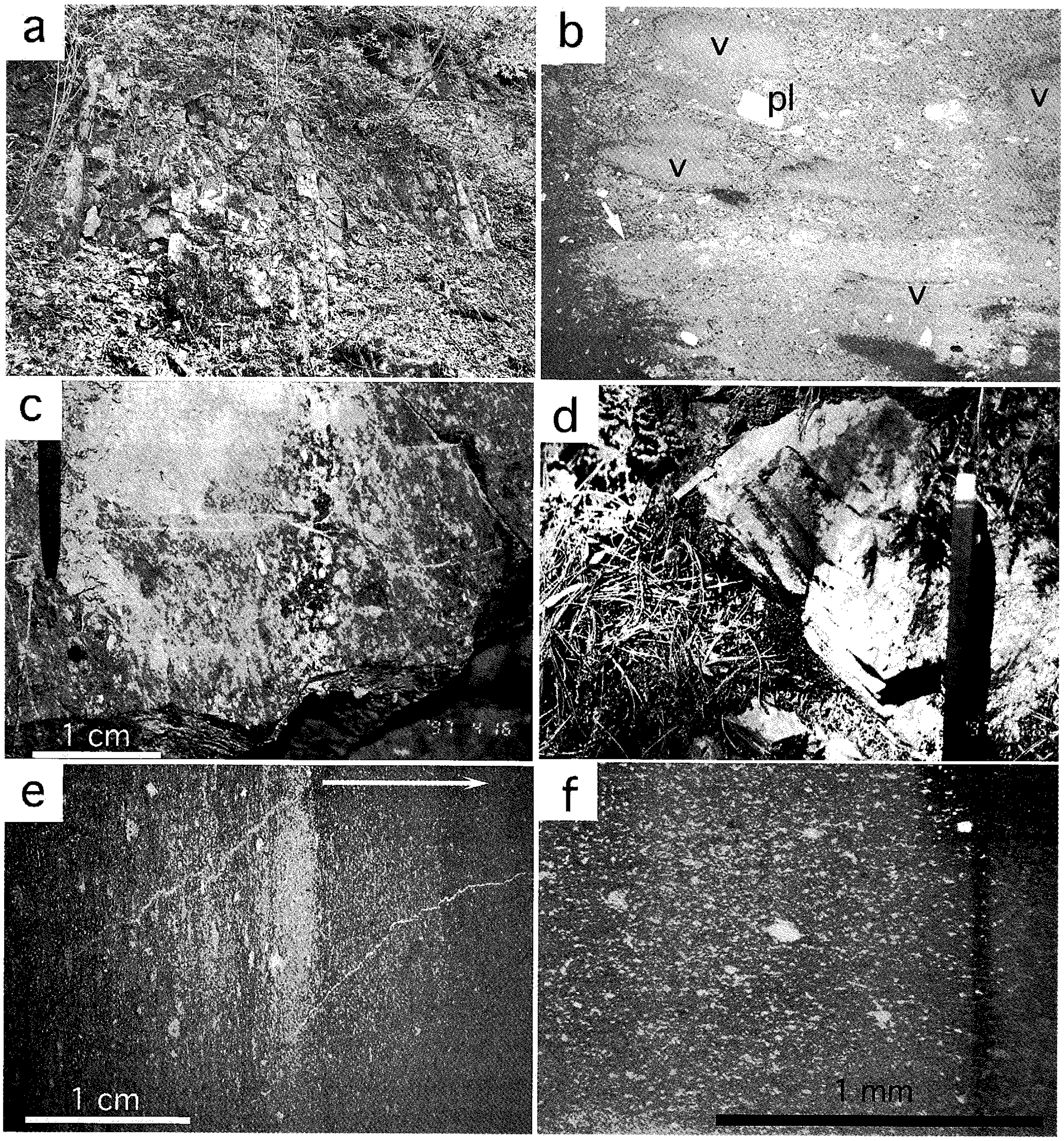

Fig. 5. Photographs and photomicrographs of the Tandodani Formation. (a) Photograph showing the alternating beds of tuffaceous sandstone and tuffaceous mudstone of the Lower Member. Each bed is from a few cm to 20 cm thick. (b) Thin section photomicrograph of tuffaceous mudstone from the Lower Member (plane polarized light). This rock includes many felsic volcanic rock fragments (v) and euhedral plagioclase crystals (pl) in a matrix of dark purple mudstone. White arrow indicates bedding plane. (c) Photograph of tuff from the Lower Member. This rock includes many granule- to pebble-sized felsic volcanic rock fragments in a matrix of felsic tuff. (d) Photograph of bedded felsic tuff of the Upper Member. (e) Thin section photomicrograph of the laminated fine felsic tuff of the Upper Member (plane polarized light). Graded bedding indicates northward facing. White arrow shows upward direction. (f) Thin section photomicrograph of the fine felsic tuff of the Upper Member (plane polarized light). This rock includes many minute laths of plagioclase.

volcanic rock fragments, plagioclase, quartz and opaque minerals (Fig. 5f). It is light grey, white or pale green. Occasionally, both the fine-grained laminated felsic tuff and the tuffaceous mudstone include microfossils such as radiolarians and conodonts. The tuffaceous mudstone includes felsic volcanic rock fragments, plagioclase, quartz, and opaque minerals.

Fossils and age: Carnian to Norian conodonts (*Epigondolella abneptis*) have been reported from laminated felsic tuff and tuffaceous mudstone of the Upper Member (Tsukada et al., 1997). The formation is therefore Late Triassic in age.

SUMMARY

The Tandodani Formation is newly defined in the Hongo area, Hida Gaien belt. It can be divided into the Lower and Upper Members. The former is composed mainly of tuffaceous clastic rocks with minor amount of felsic tuff intercalations. The Upper Member is composed mainly of felsic tuff; it yields late Triassic conodonts (Tsukada et al., 1997). At its upper limit, the formation is in fault contact with the Carboniferous Arakigawa Formation.

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河川名および地名など

Takaharagawa .... 高原川
Kamitakara .... 上宝
Tandodani .... 谷戸谷
Nebagao .... ネバケ尾
Kurabashiragawa...................... 蔵柱川
Hongo... 本郷
Moribu .... 森部