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# The Miocene in the Southern Area of Izumo City, Shimane Prefecture, Japan*

By

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## Contents



## I Introduction

The southern area of Izumo City is, since 1951, one of the Tertiary fields investigated under the leadership of Prof. S. IMAMURA by "The Research Group of San-in Tertiary" in the Geological Institute of Hiroshima University. The author, as one of the main investigators, is studying the volcanostratigraphy and volcanic activity of this area both in the field and in the laboratory.

This area is geologically considered as one of the virgin fields, since nothing other than the work of M. YAMAGAMI, by whom one of geological maps of Japan, Sanbeiyama sheet[1] in the scale of 1/200,000 was compiled in 1897, has hitherto been published. According to the investigation of the Research Group, the geology of the field concerned

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seems to be volcanologically and geohistorically very interesting and important both in San-in district and in Japan. The author, therefore, thinks that it would be of value to report the geological outline of this field. In this paper, the lithostratigraphy and volcanic activity will mainly be reported, but especially the palaeontological notes will be described by some other members of the Research Group in the near future.

The field dealt with in this paper is the southern area of Izumo City and estimated approximately as 25 km. long and 15 km. wide. The names of the investigators and their works, as to which much credit must be given for their great efforts, are reported hereunder.

1) 1951 : The NW area ; Asayama-mura (朝山村), Kônan-mura (江南村), Kiku-mura (岐久村), Kubota-mura (窪田村), Nishisusa-mura (西須佐村), Higashisusa-mura (東須佐村).
   Members : Staff of the Geological Institute, Hiroshima University ; S. IMAMURA, M. MUKAE, Y. TAI, H. TAKEDA. 3rd year class students of the Faculty of Education, Hiroshima University, 1951 ; T. HABARA, Y. NAGAMINE, H. NISHIKAWA, S. SAKAI, H. UENO, M. YAMADA.
2) 1952 : The central area ; Higashisusa-mura, Nishisusa-mura, Kubota-mura, Kakeya-chô (掛合町).
   Members : Staff ; S. IMAMURA, M. MUKAE, H. YOSHIDA, Y. TAI. 3rd year class students of the Faculty of Education, Hiroshima University, 1952 ; Y. FUKUYAMA, T. KUMAMOTO, S. KURODA, T. NAKAGAWA.
3) 1952 : The NE area ; Hiebara-mura (稗原村), Nabeyama-mura (鍋山村), Asayama-mura (a part), Kamitsu-mura (a part) (上津村).
   Members : Staff ; S. IMAMURA, M. MUKAE, Y. TAI. 4th year class student of the Faculty of Science, Hiroshima University, 1952 ; K. OKAMOTO.
4) 1953 : The S area ; Kakeya-chô, Hata-mura (波多村).
   Member : M. MUKAE.

Mr. K. OKAMOTO, graduate student of Hiroshima University, is still studying on the details concerning stratigraphy and palaeontology of the same area.

Many thanks must be stated to Prof. S. IMAMURA for his kind guidance. The advices and aids given by Mr. J. KATTO of Kôchi University and the kind help of the officers of the village- and town-offices in this area is gratefully acknowledged. Finally, particular thanks are due to the Ministry of Education for grant in aid which has

rendered possible these investigations.

## II Stratigraphy

The Miocene sediments and volcanics covering granitic rocks are widely developed in the area concerned, recently called "Iishi Bay" by H. YOSHIDA.[11] The Miocene within this area is lithostratigraphically, in ascending order, divided into the following 2 groups and 3 formations;

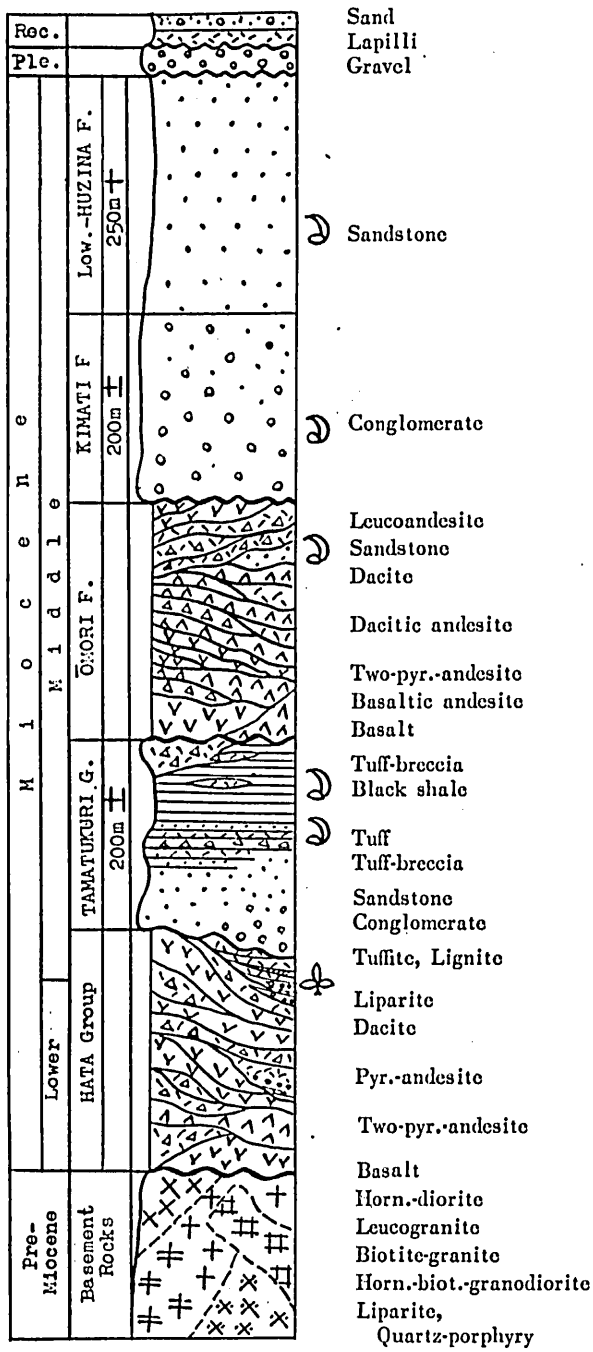
Hata (波多) Group [including Nabeyama (鍋山) Group]
Tamatukuri (玉造) Group[3]
Ômori (大森) Formation
Kimati (来待) Formation
Lower Huzina (布志名) Formation

These groups and formations are zonally arranged in such manner that the older ones are located on the southern side and the younger, on the northern side. The stratigaphical sequence of these groups and formations are correlated to those of the adjoining fields, as shown in Table 1, which was once reported by S. IMAMURA,[9,14] and Fig. 1.

Table 1 The correlation-table of the Miocene in San-in district.

| Age \ Area | Ôta and Ômori 1953 S. Imamura | | S-area of Izumo City 1954 M. Mukae | | S-coast of Shinji Lake 1939 T. Tomita and E. Sakai | | Shimane peninsula 1952 Y. Tai | |
|---|---|---|---|---|---|---|---|---|
| MIOCENE G | Izumo Group | Kimati F. | Izumo Group | Low.-Huzina F. | Matue series | Matue Bed. Hor.-tr.-basalts. Tuda Bed Ol.-tr.-basalts. | Shinji Group | Matsue F. |
| | | | | | Huzina series | Huzina Bed. | | |
| | | | | Kimati F. | | Kimati Bed. | | |
| F3 | | Ômori F. | | Ômori F. | Ômori series | Two-pyr.-andesites. Ômori Bed. | | Furue F. |
| F2 | Kawai G. | Up.-Bed. Low.-Bed. | Tamatukuri Group | Up.-Bed. Low.-Bed. | Tamatukuri series | Higashiyama-basalts Up.-Tamatukuri bed. Apo-andesites Low.-Tamatukuri bed | | Koura F. |
| F1 | Kimitani Group. | | Hata (Nabeyama) Group. | | | | | |
| Pre-Miocene | Granitic rocks | | Granitic rocks | | Granodiorites, granites, granite-aplites. | | | |

Fig. I Stratigraphical section




## A) The Basement Rocks

Granitic Rocks are the basement-rocks, surrounding the outside of the "Iishi Bay" of Miocene, distributed along the Kando River (神戸川), the Mitoya River (三刀屋川) and the Hii River (斐伊川), and are also partly found scattered in the inner section of Miocene area in Kubota-mura. Considering from the distribution, the unconformable plane between the basement-rocks and the Miocene seems to incline slightly toward NNW and to be not much deeper than the present water-level.

The facies from older to younger of the basement-rocks and their main localities are as follows;

1) Brecciated liparites ; Kamitsu-mura, Hiebara-mura.
2) Quartz-porphyries ; Kakeya-chô.
3) Hornblende-biotite-granodiorites ; Nabeyama-mura, Kakeya-chô.
4) Biotite-granites ;

Nabeyama-mura, Kakeya-chô, Tombara-chô (頓原町).

5) Leucogranites; Hata-mura, Kubota-mura and the western area.

6) Hornblende-diorites; Kakeya-chô, Hata-mura.

The geological ages of these basement-rocks are unknown but they seem to belong geologically to certain stages from the upper Cretaceous to the Paleogene.[12,13]

1) Brecciated liparite: (Fig. 1) Brecciated liparites as the basement-rocks of the Miocene are distributed around Kiyotani (清谷) (Hiebara-mura) and Kamitsu-mura. Megascopically, they are liparitic and show a sort of fluidal structure. Under the microscope, they are porphyritic, usually brecciated and thermally metamorphosed to hornfels. The phenocrysts are quartz, plagioclase (oligoclase~andesine) and a scarce amount of orthoclase. The groundmass is felsitic or glassy, including a large amount of secondary biotite. The boundary between biotite-granites and brecciated liparites is unobvious, but the latter seems to be metamorphosed by the former.

2) Quartz-porphyries: They crop out around Kakeya-chô. Megascopically, they are porphyritic and sometimes liparitic or granite-porphyritic and have some phenocrysts of quartz and plagioclase (oligoclase). The author thinks that they are petrographically quite similar to brecciated liparites but clearly different from leucogranites which is characterized with perthite. Near Kakeya-chô, they are distinctly subjected to mineralization of a large amount of sericite and pyrite. The similar facies is found also in Yoshino (吉野) and Yawatabara (八幡原) (Kubota-mura).

3) Hornblende-biotite-granodiorites: (Fig. 2) They are distributed mainly in Tane (多根) (Kakeya-chô) and Ichikubota (一窪田) (Kubota-mura) and are petrographically coarse-grained and granitic. Their essential minerals are, in order of abundance, oligoclase~andesine, quartz, biotite, green-hornblende and a little amount of perthitic orthoclase. In the field, they are evidently recognized to change gradually to biotite-granites. At Ichikubota, they are porphyritic and cut by leucogranites.

4) Biotite-granites: (Fig. 3) They are exposed around Nabeyama-mura and Tombara-chô and are coarse-grained and granitic. Their essential minerals are quartz, perthite, biotite, a little amount of plagioclase and rarely hornblende.

5) Leucogranites: (Fig. 4) They are found along the Kando River and in its western area, and are usually granitic, but sometimes aplitic or granophyre-like. The essential minerals are quartz and perthite, accompanying a little amount of plagioclase and biotite.

The author thinks that these three granitic rocks were differentiated from the same magma, because they are characterized with special kind of perthite, and are petrographically similar with one another and they seem to belong to members of the so-called San-in granites in the later Cretaceous.[12] In the field, the former two change gradually with each other and leucogranites cutting them are also probably originated from the residual magma of them.

6) Hornblende-diorites: (Fig. 5) Hornblende-diorites are distributed mainly in Yoshida (吉田) (Kakeya-chô), at Mt. Noda (野田山) (Hata-mura), Shitsumi (Shiji-mura) (志志村志津見) and Kamagatani (鎌谷) (Higashisusa-mura). Thay are usually very fresh and medium-grained and dioritic. The essential minerals are basic andesine, sometimes labradorite or oligoclase, green-hornblende and a little amount of biotite, occasionally accompanied with quartz and augite. In Yoshida, they seem to cut quartz-porphyry, because they become more and more fine-grained with approaching to the boundary. Their relation to biotite-granites is not clear for certain in the field.

### B) Hata 波多 Group (including Nabeyama 鍋山 Group)

Hata Group is the lowest one of the Miocene in this area and rests unconformably on the basement-rocks. It consists mainly of volcanics such as andesites bearing dacites, liparites and pyroxene-basalt, and is distributed around Hata-mura and Kakeya-chô, extending toward northeast and northwest. Inasmuch as Hata-mura seems to have been a main center of the volcanic activity during this age, the volcanoes extruded in this age were called "the **Hata Volcanoes**"[11] and these volcanics were called the **Hata Group** by the Research Group.

In Nabeyama-mura and Hiebara-mura, the northeastern part of this area, non-marine sediments of conglomerates, tuffites, etc., lying unconformably under the Tamatukuri Group are observed and are, according to the name of type-locality, called the **Nabeyama Group.**[10] They are stratigraphically the lowest beds of the Miocene in the northeastern area, and the andesites, intercalated between these strata, is petrographically an equivalent of the dacitic andesites of the upper part of Hata Group, so that the Nabeyama Group seems to be a heteropic facies of the upper part of Hata Group.

1) **Hata Group**: The original shapes of Hata Volcanoes are not observable, as they have been already denudated and destroyed, but a

main center of these volcanoes seems to have been situated near Hata-mura.

The Hata Group consists of large amounts of lava, tuff-breccia, tuff and agglomerate. The rock-facies of these volcanics are as follows:

Pyroxene-basalts,
Two-pyroxene-andesites,
Pyroxene-andesites,
Dacites and dacitic andesites,
Liparites.

Of these, two-pyroxene-andesites and pyroxene-andesites are most extensively distributed. In the field, the sequence of extrusion is not clear, but generally the variation from basic to acidic properties is surely observed.

Two-pyroxene-andesites: (Fig. 7) Melanocratic, basic and porphyritic. As phenocrysts, plagioclase (andesine), augite, hypersthene or pigeonite or bastite are recognizable.

Pyroxene-andesites: (Fig. 8) Porphyritic. As phenocryst, plagioclase (andesine~oligoclase) and augite are found, including sometimes quartz in the groundmass.

The occurrence of them are usually so complicated that their sequence is not easily decided.

Pyroxene-basalts (Fig. 6) and liparites were found in Yoshino (Kubota-mura). They are covered unconformably with Tamatukuri Group. Liparites, having phenocrysts of quartz and plagioclase, are regarded as the last volcanics of this group, because they cover and cut andesites of this age, while they are petrographically different from plagioliparites of Tamatukuri stage. At Anamidani (穴見谷) and Mt. Toriyamaru (鳥谷丸山) (Hata-mura), dacites are observed and seem to cover and cut two-pyroxene- and pyroxene-andesites. They have quartz and plagioclase (oligoclase) as phenocryst, accompanied with augite. Hornblende-quartz-andesites at Matsukasa (松笠) (Kakeya-chô) must be related to dacites. Usually, the volcanics, altering deeply to propylite etc. are distinguishable from the more fresh rocks in the Ômori stage.

2) **Nabeyama Group:** This group is scatterered in Nabeyama-mura, Hiebara-mura and Kakeya-chô and consists of two tuffaceous beds and andesites intercalated between them. Accordingly the group is divided lithostratigraphically into the upper and the lower parts in this paper but no geological gaps between them have been found obviously in the field.

b) The upper part: (2) Tuffite, tuffaceous shale, conglomerate and

thin layers of lignite.

(1) Altered pyroxene-andesites.

a) The Iower part: Muddy tuff, tuff-breccia, tuffaceous conglomerate.

a) The lower part: They are distributed at Kayano (萱野) (Nakatane, Kakeya-chô), Maeneba (前根波) (Nabeyama-mura), Hotokedani (仏谷) and Ageyama (上山) (Hiebara-mura).

At Kayano, the strata, in ascending order, are found as follows: Green-muddy tuff and tuff-breccia (about 25m. thick), conglomerate (3.5m. thick), brown-tuffite (1m. thick), which overlie unconformably on biotite-granite and the total thickness is estimated as about 30m. The constituents of conglomerate are rounded pebbles of granites, liparites, quartz-porphyries and andesites of fist size, which are cemented with quartz-sandstone. At Maeneba, andesitic tuff and tuffaceous conglomeratic sandstone are distributed, covering biotite-granite and lying under the altered pyroxene-andesite flow of the upper part and Tamatukuri Group. At Hotokedani and Ageyama, some beds of tuffaceous sandstone, coarse-grained quartz-sandstone, tuff-breccia and conglomerate are here and there observed and overlie brecciated liparites and are cut or coverd by altered pyroxene-andesites of the upper part. In the lower part within this area, fossils, with the exception of some vegetable drifts, have never been found.

b) The upper part: The upper part is divided into (1) altered pyroxene-andesites and (2) tuffite, tuffaceous shale and conglomerate. The former consists of lava-flows, agglomerates and tuff-breccias of some rock-facies such as altered augite-andesites, altered dacitic andesites (Fig. 9) etc. and usually these andesites contain phenocrysts of sodic plagioclase and augite, accompanied with quartz in interstices and are altered deeply to propylite.

At Fukatani (深谷) (Nabeyama-mura), the upper part consists of, in ascending order, muddy-tuff, conglomerate, tuffite, which is about 40 m. in total thickness. Coaly shale with lignite, 10 – 40 cm. thick and vegetable drifts are observed at the upper part. At Togura (戸倉) (Hiebara-mura), it consists of tuff-breccia, tuffite and tuffaceous shale. At Maeneba (前根波), it consists of conglomerate, tuffaceous sandstone and shale, intercalated with thin coaly shale and covers the altered andesites. At Tsunotani (角谷) (Hiebara-mura), it consists of tuff and tuffite intercalated with some thin layers of lignite. In that roof-tuffite (Loc. 1), *Metasequoia japonica* (ENDO) and *Comptoniphyllum Naumanni* NATHORST were found by K. OKAMOTO. Once, the same fossil-plants were reported by J. KATTO in this field.[4] In the tuffaceous shale around the temple

dedicated to Kannon (Loc. 2) at Okitani (沖谷) (Hiebara-mura), which seems to be a part of the upper part, some fossil-fishes of fresh water and fossil-plants were found by the author. After the study of K. OKAMOTO, fossil-fishes are considered to belong to Cyprinidae, and fossil-plants, to *Cinnamomum* sp., and *Salix* sp.. It thus follows that the Nabeyama Group is certainly believed a sort of fresh water sediment and volcanics.

3) Geological age of Nabeyama Group and Hata Group: According to the stratigraphy and the occurrence of fossil-plants [*Metasequoia japonica* (ENDO) and *Comptoniphyllum Naumanni* NATHORST], the age of Nabeyama Group is undoubtedly the early middle Miocene ($F_2$); while the age of Hata Group may be the lower to middle Miocene ($F_1$-$F_2$), as the Nabeyama Group is equivalent to the upper part of Hata Group, and the Hata Group may be correlated volcanostratigraphically to the Kimitani Group in Ômori area.[9]

### C) Tamatukuri (玉造) Group

This group consists of conglomerate, sandstone and shale, accompanied with tuff-breccia, and is generally distributed along the northern zone of the Hata Group and the southern zone of the Ômori Formation; i. e., from Nishisusa-mura, via Higashisusa-mura to Hiebara-mura. Palaeontologically and lithologically, the group concerned is equivalent to the Tamatukuri Group in the adjacent eastern type-area investigated by T. TOMITA and E. SAKAI,[3] so this group was called the Tamatukuri Group by the Research Group. This group usually abuts the basements, influenced by the irregular topography because the surface of the Hata Group and granitic rocks were very uneven. Andesitic tuff-breccias and liparites are obesrved in the middle part of this group and basic tuff-breccia, at the extremely upper part, so volcanic activities of this age are recognized in this area too, where, because of their weakness, no centers may be found. This group is lithologically divided into the lower and the upper beds.

1) The Lower Bed: The lower bed consists of basal conglomerate, feldspathic quartz-sandstone, tuffaceous shale, tuff and tuff-breccia. Basal conglomerate is thick in one place but changes to sandstone in another. Materials of the conglomerate are rounded pebbles of granitic and andesitic rocks, 5-20 cm. in diameter, and cemented with feldspathic quartz-sandstone and rarely mixed with boulders at Yoshino (Kubota-mura) and Fukatani (Nabeyama-mura).

Feldspathic quartz-sandstone is the main member of the lower bed and distributed extensively throughout this area. It is medium-grained quartz-sandstone bearing feldspar, sometimes associated with small pebbles and thin tuff-beds. Andesitic tuff, tuff-breccia, liparites and liparitic tuff are observed in the upper layer of this lower part. Usually, marine shells are found abundantly near this horizon (Loc. 3, 4, 5, 6, 7, 8 and 11). At Miyauchi (宮内) (Higashisusa-mura), plagioliparites, intruding into this sandstone bed, are observed and seem to belong to a part of the volcanics in this age. They are fluidal in texture, having a few amount of phenocrysts such as plagioclase and biotite. The thickness of the lower bed varies from about 300 m. at the eastern area to 100 m. at the western area.

2) The Upper Bed: The upper bed consists of black shale, black-colored sandy shale, bearing a few thin layers of tuff. But at Hirata (平田) (Nishisusa-mura), basic tuff-breccia, as an exception, is observed successively on the black shale, which seems to be also a member of this upper part. This upper part is accumulated continuously from the lower bed. In the black shale, marine shells of small size, smaller foraminifera etc. were sporadically found (Loc. 9 and 10). The thickness of the upper bed is 50 m. at the eastern area and 150 m. at the western and central area.

3) The relation of the Tamatukuri Group to the Hata Group and the Ômori Formation: The former covers and abuts the Hata Group and the basement-rocks, with basal conglomerate or sandstone. The materials of conglomerate are mainly derived from the basements and the Hata Group. Some evidences of clinounconformity between the Nabeyama Group and the Tamatukuri Group are observable at Tsunotani (Hiebara-mura) and some other places. The relation of the Tamatukuri Group to the Hata (Nabeyama) Group is distinctly unconformable, at least, within this area. Pyroxene-basalts, the lowest member of the Ômori Formation, covers the different horizons of the Tamatukuri Group, so it is thought that pyroxene-basalts have covered the erosion-surface of the Tamatukuri Group. Some of faults which cut the Tamatukuri Group never cut the Ômori Formation. Basing on these evidences, the mutual relation between these group and fomation seems to be unconformable.

4) Geological age of the Tamatukuri Group.

Marine fossils such as *Pecten kagamianus* YOKOYAMA and *Siratoria siratoriensis* OTUKA, etc. in sandstone and near tuff horizon of the lower bed, and *Propeamussium tateiwai* KANEHARA, etc. in the black shale

of the upper bed were found. Accordingly these are undoubtedly composed of marine sediments, palaeontologically as well as lithologically equivalent to the Tamatukuri Group in the adjacent eastern type-area and the Kawai Group in the western area. The age of this group is clearly the middle Miocene ($F_2$).

### D) Ômori (大森) Formation

The formation of volcanics and sediments, covering the Tamatukuri Group and lying under the Kimati Formation, are called the Ômori Formaion. The Ômori stage is an age of violent volcanic activities, the center of which is surely located in this area. According to the locality-name of the volcano-center: "Izumo-susa" (出雲須佐) (Asayama-mura), the volcanoes in this age within this area are called "the **Susa Volcanoes**"[6] and this formation is called the Omori Formation, because the formation is an equivalent of the Ômori Formation in the adjacent areas. The great voluminous ejecta from the Susa Volcanoes covers the area of about 15 km. square around Izumo-susa.

The main rock-facies of this formation are, from older to younger, as follows:

Pyroxene-basalts,
Basaltic andesites,
Two-pyroxene-andesites,
Pryoxene-hornblende-andesites,
Dacitic andesites and dacites,
Two-pyroxene-bearing leucoandesites.

As mentioned above, miscellaneous kind of facies from basic to acidic are found in the volcanics, but dacites and two-pyroxene-bearing leucoandesites are most predominantly exposed. At Nakabata (中畑) (Kônan-mura), marine sediments, such as sandstone, conglomeratic sandstone and tuffaceous sandstone, are intercalated with them.

1) The localities and petrography of each volcanics

a) Pyroxene-basalts and basaltic andesites: (Fig. 10) They are distributed from Hiebara-mura at east, via Higashisusa-mura and Nishisusa-mura to Kubota-mura at west, in close connection with the Tamatukuri Group. In Hiebara-mura, they are black-colored and compact, sometimes abundant in columnar joints, and occurred as dike, lava-flow or sheet. They are, under the microscope, usually very fresh and fine crystalline without phenocryst and distinctly basaltic in texture; while their essential minerals are labradorite~basic andesine, titaniferous augite

and magnetite, sometimes bearing a little amount of hypersthene and antigorite. In Higashisusa-mura and its western area, they are occurred as lava-flow and partly as dike and are porphyritic, sometimes doleritic, hard and compact, frequently bearing xenocrysts of quartz. At Yawatabara (Kubota-mura), they are covered with lava-flows of two-pyroxene-andesites successively. A part of basaltic andesites in the NW area is somewhat spilitized.

b) Two-pyroxene-andesites: (Fig. 11) They are appeared as lava-flows, pyroclastics and sometimes dikes in the western and central area. Usually, they are porphyritic and, microscopically, have a large amount of augite, andesine and magnetite, bearing hypersthene and rare amount of quartz in the groundmass of the same minerals.

c) Pyroxene-hornblende-andesites: Hornblende-andesites are very rare-ly exposed throughout this area and the Miocene age, but are found merely at Shirataki (白滝) to Higashiyamanaka (東山中) (Nishisusa-mura). They are porphyritic, having phenocrysts of oligoclase and hornblende and a less amount of augite and seem related to the two-pyroxene-andesites mentioned above.

d) Dacitic andesites and dacites: (Fig. 12) They are most extensive and voluminous. Dacitic andestes are observed at Mt. Kuroyama (黒山) (Higasisusa-mura). Dacites are distributed vastly from Hiebara-mura, via Asayama-mura and Nishisusa-mura to Kubota-mura and divided into two types: One is coarse-grained and porphyritic, while the other is aphanitic. The latter seems somewhat earlier than the former in the field. They are both accumulated as lavas and pyroclastics, but sometimes a part of them seems hypabyssal. Phenocrysts of these facies are andesine~oligoclase, corroded quartz, bearing a few opacitized hornblende and augite and the groundmass of the coarse-grained dacites are composed of the same kind of fine crystalline minerals.

e) Two-pyroxene-bearing-leucoandesites: They are the last member of the Ômori volcanics and distributed as lava-flows or pyroclastics in the neighborhood of the Kimati Formation in its southern zone, from Hiebara-mura via Asayama-mura and Kônan-mura to Kiku-mura. The agglomerates conspicuosly exposed at Tachikue (立久恵) (Asayama-mura) seem to belong to these facies. They are, megascopically, black-colored and compact, while, microscopically, their phenocrysts are very few, but are composed of oligoclase, augite and sometimes hypersthene and the groundmass is cryptocrystalline and felty.

2) Geological age of the Ômori Formation and its relation to the upper formation: From the sandstone, found at Nakabata (Konan-mura)

(Loc. 12), marine shells such as *Pecten* cf. *kagamianus* YOKOYAMA, etc. were discovered.

This formation is believed the middle Miocene ($F_3$) according to the occurrence of these marine fossils and clearly equivalent to the Ômori Formation in the adjacent areas from the standpoint of volcanostratigraphy.

The relation between the Tamatukuri Group and the Ômori Formation is unconformable as referred to previously. The relation between the Kimati and the Ômori Formation is unconformable too in this area, because the former consists mainly of rounded pebbles and boulders of volcanics derived from the Ômori Formation.

### E) Kimati (木待) Formation

Kimati Formation is composed of boulder-conglomerate or conglomeratic sandstone mainly derived from the Ômori volcanics and developed along the southern zone of the San-in railway line. This formation dips to N with low angles and gradually changed upwards to sandstone of the lower Huzina Formation. In this formation at the eastern environs of Izumo City, two-pyroxene-andesitic tuff-breccia was found by K. OKAMOTO, so the volcanic activity in the Ômori stage seems to have been prolonged until this age. Since marine shells such as *Pecten kagamianus* YOKOYAMA, etc. were found in the sandstone at Hanagura (花蔵) (Kikumura) (Loc. 13), this formation is palaeontologically and lithologically an equivalent of the Kimati Formation in the adjoining areas[3] and the middle Miocene ($F_3$). The thickness of this formation is 150 to 250 m. in this area.

### F) The lower Huzina (布志名) Formation

This formation, which consists of fine-grained sandstone and sandy shale, is developed in the northern area of the Kimati Formation to the coast of the Japan Sea, accumulating successively to the latter. The lower Huzina Formation dips monoclinally to the north with angles of about 15 degrees. Characteristic marine shells of the Huzina fauna were founded abundantly at the coast of Oda (小田) (Loc. 15) and sporadically in the sandstone within this area (Loc. 17). Palaeontologically and lithologically, this formation belongs to the middle Miocene ($F_3$) and continues laterally to the same formation in the eastern type-field.[3] The thickness of this formation is over 250 m. The volcanic activity was not recognizable in this area.

## III Volcanic activity

1) As alluded to precedingly, the Miocene volcanic activity in this area is clearly considered to have been very strong and violent.

2) This is volcanostratigraphically divided into three cycles of the Hata, Tamatukuri and Ômori stages. Especially, the activities in the Hata and Ômori stages were most extensive and strongest.

3) According to the microscopic study of the volcanics during three cycles, they undoubtedly belong to the calc-alkalic rock-series ; i.e., basalt-andesite-dacite-liparite-series.

4) On the basis of the sequences of extrusion observed in the field, the volcanics of each cycles show surely the phenomena of magmatic differentiation from basic to acidic properties.

5) The places of the volcanic activities move from the southern mountain-zone to the northern coastal zone in the course of geological age.

6) The Susa-volcanics are respectively more fresh than the Hata-volcanics which usually are deeply altered to propylitic rocks. From these lithological evidences and stratigraphical relations, the main activities of the Susa Volcanoes seem to have occurred on land, although a part of them may have been submarine, because the volcanics are partly spilitized and marine sediments are locally intercalated.

## IV Conclusion

1) The Miocene series occupies the area, 25 km. long and 15 km. wide in the southern part of Izumo City. This series resting on granitic rocks is stratigraphically classified into 2 groups and 3 formations as follows :

a) Hata group, the lowest one of this series, is developed in the southern zone; i.e., mainly Hata-mura and Kakeya-chô. This group consists of pyroclastics and lava-flows of mainly andesitic rocks. As Hata Volcanoes in this stage are already denudated and destroyed, their original shapes are not recognizable.

Nabeya Group, which seems to be a heteropic facies of the upper part of the Hata Group, is distributed in the northeastern part of this area; i.e., Nabeyama-mura, Hiebara-mura and Kakeya-chô. This group consists of non-marine sediments of tuffite, conglomerate and andesites, intercalated with thin layers of coaly shale and lignite. On the basis

of the stratigraphy and the occurrence of some fossil-plants, the age of this group is identified as the early middle Miocene ($F_2$).

b) Tamatukuri Group is marine sediments at the first transgression of the Miocene in this area, and exposed zonally and intermittently along the northern zone of Hata Group from Hiebara-mura to Kubota-mura. As this group is accumulated upon uneven surfaces of the Hata Group and the Basement-rocks, it usually abuts them. In the Tamatukuri Group, several kinds of marine shell, such as *Pecten kagamianus* YOKOYAMA, etc. are contained, so this group is identical as the middle Miocene ($F_2$). This group seems to be little folded and in some places shows basin-structure controlled by the original shape of the basement. This strata are cut by some faults before the accumulation of the Ômori Formation.

c) Ômori Formation consists mainly of volcanics of the Susa Volcanoes, intercalated with marine sediments. The volcanic activities in this area is clearly one of the strongest within San-in district. The main activities of the Susa Volcanoes seem lithologically and geologically to have occurred on land. Palaeontologically as well as stratigraphically, this formation is identified as the middle Miocene ($F_3$). In the field, the erosion- and structural gaps are observable between the Ômori Formation and the Tamatukuri Group.

d) The second transgression started on this area, somewhat uplifted by the accumulation of Ômori volcanics. The sediments at this stage are the Kimati and the lower Huzina Formations, in which marine fossils are found and accordingly identified as the middle Miocene ($F_3$). A little amount of tuff-breccia is observed merely in the Kimati stage.

2) Generally, the Miocene strata within this area are developed zonally; the older in the southern zone and the younger in the northern zone. It is very interesting that the places of sedimentation have moved from south to north and the ones of the volcanic activities, too, from south to north in the course of geological age. The later crustal movements cut this series by many kinds of fault, which trend NNE－SSW, etc..

3) The Miocene volcanic activities in this area were very violent, and are divided into three cycles of the Hata, Tamatukuri and Ômori stages. In each cycle, the phenomena of the magmatic differentiation from basic to acidic properties are observable. The rocks of these three cycles belong petrologically to the calc-alkalic rock-series.

4) Conclusively, the Miocene in this area is most probably the southern peripheral sediments of the Shinji (宍道) Geosyncline.

## V Bibliography


1. YAMAGAMI, M., 1897; Geological map of Japan in the scale of 1/200,000, "Sanbeiyama sheet" and its Explanatory Text.
2. TOMITA, T., 1936; Geology of Dôgo. Oki Islands in the Japan Sea, Jour. Shanghai Sci. Inst., Sec. 2, Vol. 2.
3. TOMITA, T. and E. SAKAI, 1939; Cenozoic Geology of the Huzina-Kimati District, Izumo Province, Japan. A Contribution to the Igneous Geology of the East-Asiatic Province of Cenozoic Alkaline Rocks, Jour. Shanghai Sci. Inst. Sec. 2, Vol. 2.
4. KATTO, J., 1950; The Teriary of the Shimane-Hôkoku Coal Mine. Especially concerning to coal seams. (in Japanese) "Chishitsu", Ôsaka-Chikashigen-Kyokai.
5. IMAMURA, S. and the others, 1952; On the crustal movement and volcanic activity of the later Cenozoic era in Chūgoku district, (in Jap.) Jour. Geol. Soc. Jap., Vol. 58, No. 682.
6. YOSHIDA, H. and the others, 1952; On the volcanic activity in the central part of Shimane Prefecture, (in Jap.) Jour. Geol. Soc. Jap., Vol. 58. No. 682.
7. TAI, Y., 1952; Stratigraphy and Geological Structure of the Central Area of Shimane Penisula, Shimane Prefecture, Part 1, (in Jap.) Jour. Geol. Soc. Jap., Vol. 58, No. 687.
8. TAI, Y., 1953; ditto, Part 2. Jour. Geol. Soc. Jap., Vol. 59, No. 690.
9. IMAMURA, S., 1953; The outline of the Tertiary stratigraphy in the central and western parts of Shimane Prefecture, (in Jap.) Rep. West Jap. Branch Geol. Soc. Jap., No. 12.
10. MUKAE, M., 1953; The Neogene of the southern area of Izumo City, (in Jap.) Rep. West Jap. Branch, Geol. Soc. Jap., No. 12.
11. YOSHIDA, H., 1953; Some problems on the Tertiary formation in Shimane prefecture, (in Jap.) Geol. Rep. Hiroshima Univ. No. 3.
12. KINOSAKI, Y., 1953; On the Granitic rocks in Chūgoku, and the molybdenite and wolframite deposits in them, (in Jap.) Geol. Rep. Hiroshima Univ. No. 3
13. YAMAMOTO, T., 1954; Geology and Ore Deposits of the Daito Mining District, Shimane Prefecture, (in Jap.) Geol. Rep. Hiroshima Univ. No. 4.
14. IMAMURA, S., 1954; Green-tuff of the central and western parts of San-in District, (in Jap.) Jour. Geol. Soc. Jap. Vol. 60, No. 706.
15. IKEBE, N., 1954; Cenozoic Biochronology of Japan, Contributions to the Cenozoic Geohistory of Japan, Jour. Inst. Polytechnics Osaka City Univ., Vol. 1, No. 1.

# Explanation of Microphotographs

Fig. 1 Brecciated liparite-hornfels, Okitani (Hiebara-mura). + nicol, × 45. Section-No. 52-9 by M. Mukae.
Numerous secondary biotites can be seen in the groundmass.

Fig. 2 Hornblende-biotite-granodiorite, Mitsushiro (Matsukasa, Kakeya-chô). + nicol, × 20. Section-No. F-2773140 by Y. Fukuyama. H; Hornblende, B: Biotite, P: Plagioclase, O: Perthitic orthoclase, Q: Quartz.

Fig. 3 Biotite-granite, Tombara-chô. + nicol, × 20. Section-No. 51-41 by M. Mukae.
Q: Quartz, B: Biotite, O: Perthitic orthoclase.

Fig. 4 Leucogranite, Kakeya-chô. + nicol, × 20. Section-No. 53-70 by M. Mukae.
Q: Quartz, O: Perthite, P: Plagioclase.

Fig. 5 Hornblende-diorite, Yoshida (Kakeya-chô). + nicol, × 20. Section-No. 53-48 by M. Mukae.

Fig. 6 Augite-basalt, belonging to Hata Group, Yoshino (Kubota-mura). + nicol, × 45. Section-No. 51-58 by M. Mukae.
The essential minerals are basic andsine, augite and magnetite.

Fig. 7 Two-pyroxene-andesite, belonging to Hata Group, Iharadani (Kakeya-chô). + nicol, × 45. Section-No. 53-45 by M. Mukae. The Phenocrysts are andesine, augite and hypersthene.

Fig. 8 Augite-andesite, belonging to Hata Group, Ryūzugadaki (Matsukasa, Kakeya-chô). // nicol, × 45. Section-No. 53-31 by M. Mukae. The Phenocrysts are andesine and augite.

Fig. 9 Altered dacitic andesite, belonging to Nabeyama Group, Misaka (Hiebara-mura). + nicol, × 45. Section-No. Oo-521016-31 by K. Okamoto. The essential minerals are sodic andesine, quartz and a little amount of bastite.

Fig. 10 Augite-basalt, belonging to Ômori Formation, Ageyama (Hiebara-mura). + nicol. × 45. Section-No. Ln 520612-14 by K. Okamoto. The essential minerals are basic andesine, augite and magnetite.

Fig. 11 Two-pyroxene-dacitic andesite, belonging to Ômori Formation, Mt. Kuroyama (Higashisusa-mura). // nicol, × 20. Section-No. F-27110601 by Y. Fukuyama. The phenocrysts are andesine and augite, bearing hypersthene.

Fig. 12 Dacite, belonging to Ômori Formation, Mt. Ôin (Higashisusa-mura). + nicol, × 20. Section-No. F-2772801 by Y. Fukuyama. The Phenocrysts are oligoclase, quartz and augite.

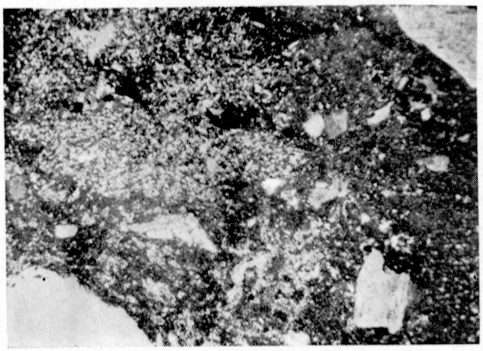


Fig. 1

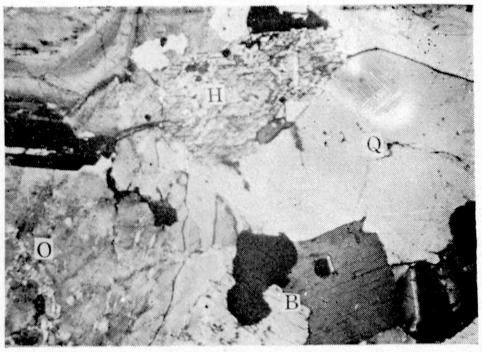
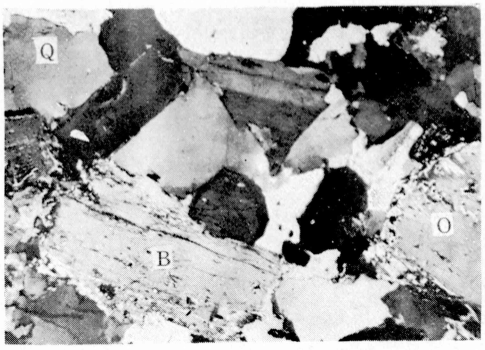



Fig. 2

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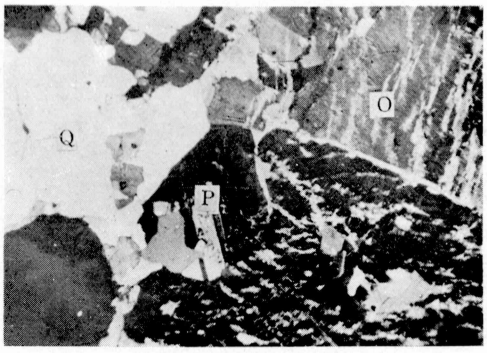
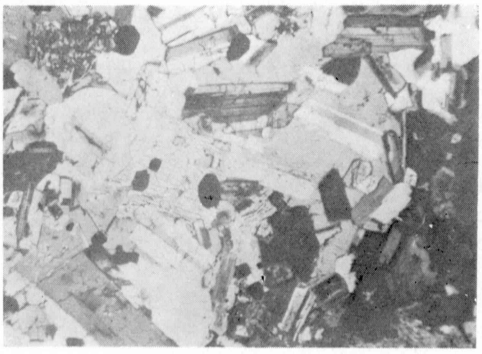



Fig. 4



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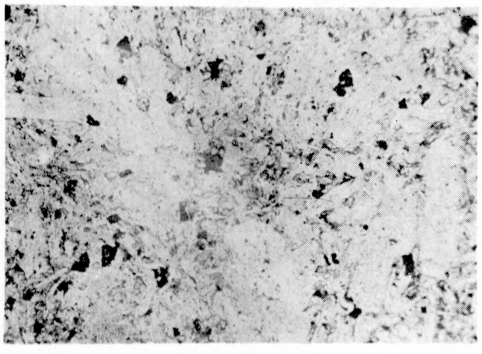


Fig. 6

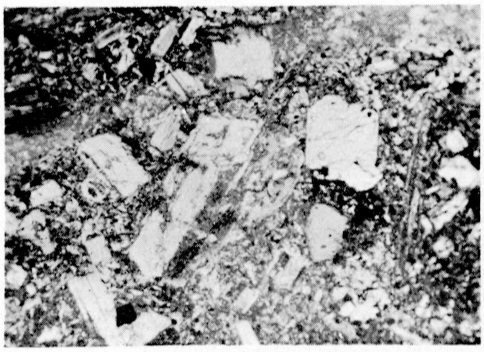


Fig. 7

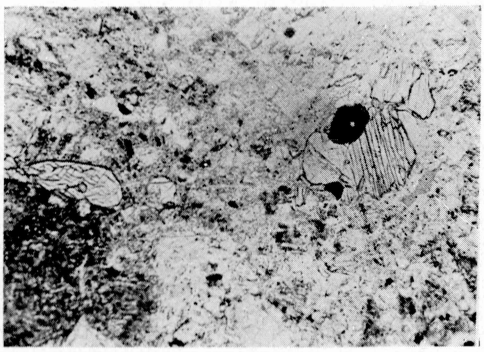


Fig. 8

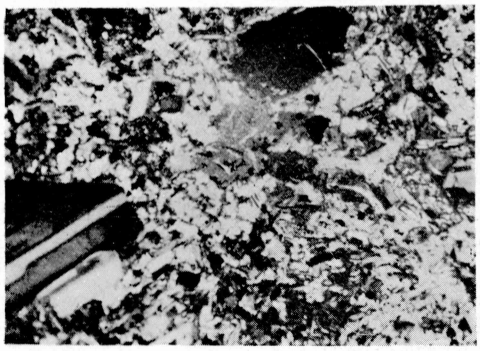


Fig. 9

Fig. 10

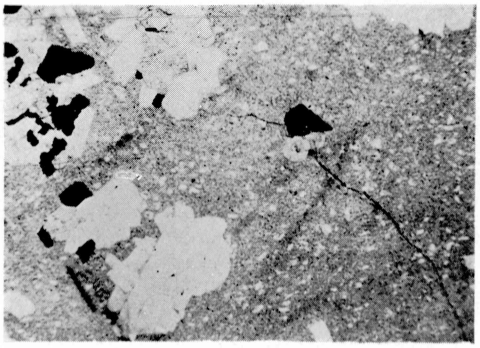


Fig. 11

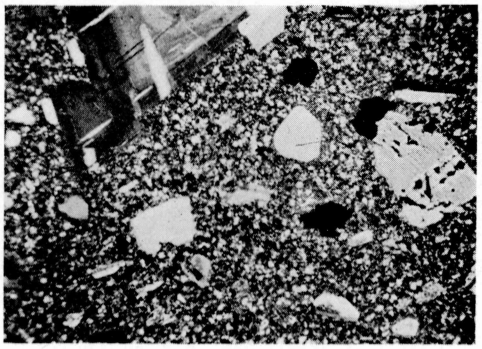
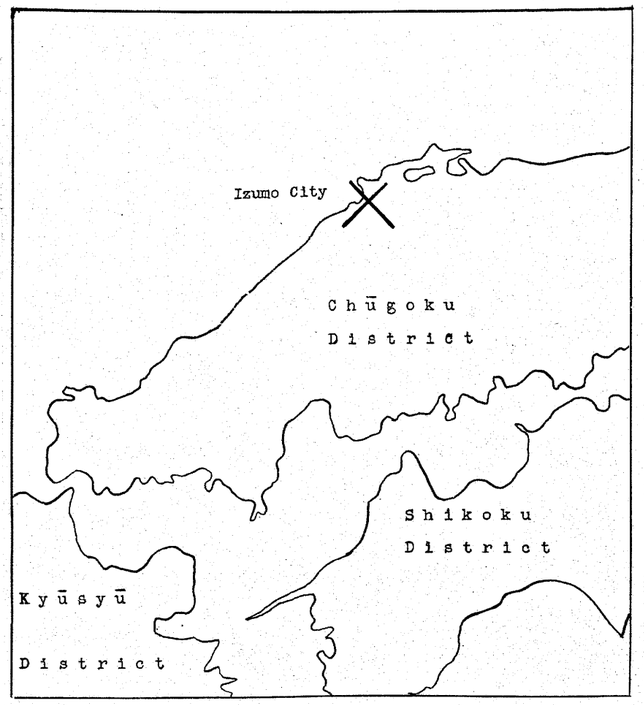


Fig. 12

# GEOLOGICAL MAP OF THE SOUTHERN AREA OF IZUMO CITY

Compiled by Michitoshi MUKAE 1954




Scale
0 1 2 3 4 5km

N

## L E G E N D

**Quaternary**

Rec. : The ejecta from SANBŌI Volcano. — Lapilli, Ash.

Ple. : YAMAMAWARI Group. — Gravel, Sand.

**Miocene**

Lower HUZINA Formation. — Sandstone, Sandy-shale.

KIMATI Formation. — Conglomerate.

ŌMORI Formation. (The volcanics from SUSA volcanoes)
- Leucoandesites.
- Dacites.
- Dacitic andesites.
- Conglo., S.S., Sh., Tuffite.
- Two-pyroxene-andesites.
- Basaltic andesites.
- Basalt.

TAMATUKURI Group.
- Upper Bed. — Tuff. / Black shale.
- Lower Bed. — Tuff, Tuff-breC, Liparites. / Sandstone, Conglomerate.

( HATA-MURA Area )

HATA Group. (The volcanics from HATA volcanoes)
- Liparites.
- Dacites.
- Andesites.

( NABEYAMA-MURA Area )

NABEYAMA Group
- Upper — Tuff-sh., Tuffite, Lignite
- Lower — Altered andesites. / Tuff-sh., S.S., Conglo.

**Pre-Mio.**

The Basement Rocks.
- Horn.-diorites.
- Leucogranites.
- Biot.-granites.
- Biot.-horn.-granodiorites.
- Quartz-porphyries. Liparites.

Fossil locality: Animal / Plant

Fault

Synclinal axis

IZUMO CITY
MAGI
CHĪMIYA
HII RIVER
JAPAN SEA
KŌNAN-MURA
KAMITSU-MURA
SAKURA
HIEBARA-MURA
OKITANI
Mt. ŌFUKURO
KUMURA
NAKABATA
ASAYAMA-MURA
NOJIRI
ODA
HAMAGURA
OTTACHI
MIMIGU
KIKU-MURA
NEBA
NABEYAMA-MURA
FUKATANI
Mt. ŌIN
OTSUKAMIYA
IZUMOSUSA
Mt. KUROYAMA
KAYANO
HIGASHISUSA-MURA
SHIMOTONE
KUBOTA-MURA
ICHIKUBOTA
ORO
MATSUKASA
KAKEYA-CHO
Mt. TORIYAMARU
HASHINAMI
YOSHINO
NISHISUSA-MURA
MOMMAGARI
Mt. ONDAKA
ANAMIDANI
YOSHIDA
Mt. MANJU
IRIMA
HATA-MURA
HATA
Mt. NODA
ONYA
TSUKAGA
TOMBARA-CHO
KANDO RIVER
MITOYA RIVER