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Petrographic properties of the acidic volcaniclastic deposits in the Omine Belt, western margin of the northern Fossa Magna region, central Japan

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Abstract

The Omine Belt (Kosaka et al. 1979) is lying from Otari to Matsumoto with 65km in length and 5～7km in width along the Itoigawa-Shizuoka Tectonic Line, which is the western manginal fault of the Fossa Magna region. The Omine Belt is burried up by a large amount of non-marine normal clastic and volcaniclastic sediments which ranges in age from Pliocene to early Pleistocene. Plio-Pleistocene strata in the Omine Belt are divided into the Otari and Omine Formations in ascending order.

Volcaniclastic sediments of the Otari Formation are andesitic. On the other hand, most of volcaniclastic sediments of the Omine Formation are acidic. In this paper, acidic volcaniclastic sediments are collected and analised in petrographically.

9 samples of the Otari Formation and 64 samples of the Omine Formation are analised. The results are as follows 1) Acidic volcaniclastic sediments in the Omine Belt are made up largely by pumiceous vitric tuff and welded tuff in lithologically. 2) Most of welded tuff beds are rhyolitic petrologically in which biotite occur as main heavy minerals. 3) The Takagariyama tuff I・II, which are characterized by a dominance of orthorhombic pyroxene as heavy minerals, are correlative to the Nyukawa Pyroclastic Flow Deposits and Ebisutoge Pyroclastic Deposits in the Takayama Basin, west of Japan Alpus.

Introduction

Two tectonic trends are recognized in Neogene strata of the Northern Fossa Magna region. The one is the Shinetsu Tectonic Trend which is running from Nagano to Niigata regions of NNE to SSW trend. Another one is the Omine Tectonic Trend which is running along the Itoigawa-Shizuoka Tectonic Line (Kosaka, 1984). The

Omine Belt (Kosaka, 1980) is the importnat tectonic zone representing the Omine Tectonic Trend which is lying along the Itoigawa-Shizuoka Tectonic Line of the Northern Fossa Magna region (Kosaka, 1984) (Fig.1). The Belt is a narrow tectonic basin buried up by a large amount of coarse-grained clastic sediments and pyroclastic rocks of Plio-Pleistocene in age. It means that alluvial fans has been formed during that time associating with a volcanism in this tectonic zone thereat (Kosaka, 1991).

Plio-Pleistocene sediments of this belt is divided into the Otari and Omine Formations in ascending order. The stratigraphy of the formations has been discussed in detail (Kosaka, 1991). Nagahashi et al. (1996) has reported that the Takagariyama Tuff

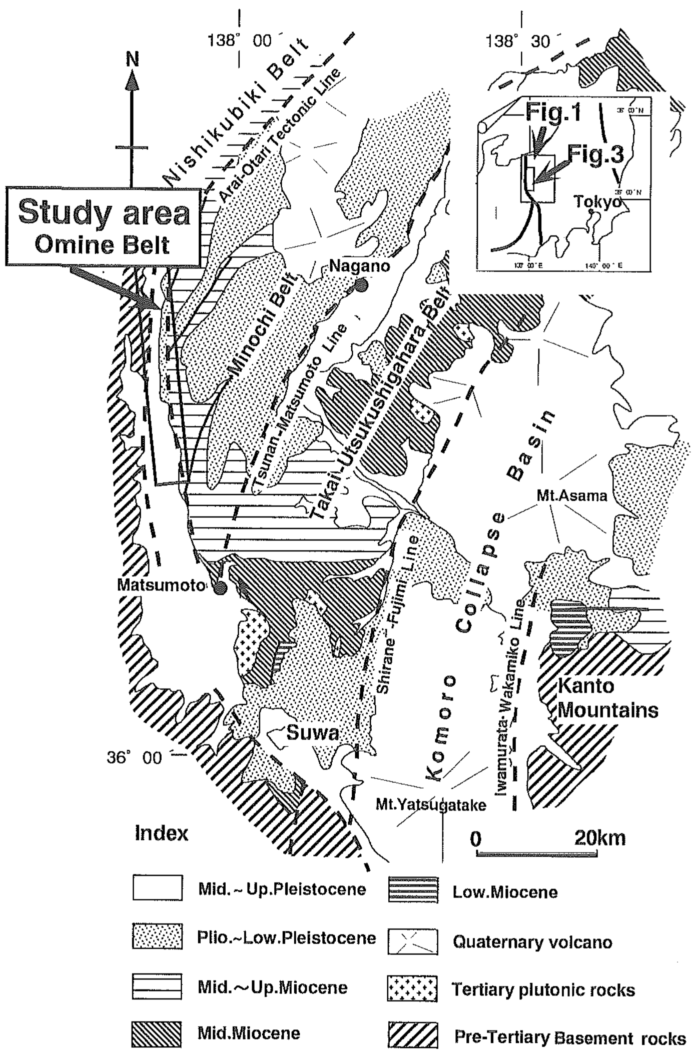


Fig.1 Map showing the study area (modified from Kosaka et al., 1998).

I and II of the Omine Belt are correlatives with the Nyukawa Pyroclastic Flow Deposits and Ebisutoge Pyroclastic Deposit distributed in the Hida Mountains.

Recently, the reports on the widespread tephra of Pliocene in age distributed in the central part of Japan have been published (Kurokawa et al., 1998). The acidic volcaniclastic deposits of the Omine and adjacent areas should be paid more attentions as one of the provenance of Plio-Pleistocene tephras distributed extensively in these areas.

The main subject of the present article is to describe petrograpy of the acidic volcaniclastic deposits of the Omine Belt. Petrographical data of acidic tuff beds of the Omine Belt may be valuable for establishing the correlation of Plio-Pleistocene formations distributed in central part of Honshu, Japan.

General geology

A number of studies have been carried out stratigraphically in the Omine Belt by previous workers (Himekawa Collaborative Research Group, 1958; Tanaka and Hirabayashi, 1964; Kosaka et al, 1979; Kosaka and Arai, 1982; Kato and Sato, 1983; Kato et al., 1989). Kosaka (1991) divided the sediments of the Omine Belt into the Otari and Omine Formations in ascending order. The Otari and Omine Formations are lithologically subdivided into the lower, middle and upper members respectively (Figs. 2 and 3). The Uchu Sandstone and Mudstone Member which is the lower member of the Otari Formation consists mainly of mudstone and sandstone beds, measuring 460m in thickness. Shallow marine molluscan fossils of late Miocene to early Pliocene in age occured in the member (Kosaka et al., 1979). The Hosogai Conglomerate Member which is the middle member of the Otari Formation is separately distributed in the northern and southern parts of the Omine Belt. The member consists mainly of boulder to pebble conglomerate beds. Three acidic tuff beds, that is the Ht1, Ht2 and Ht3, are intercalating in the member (Kosaka and Arai, 1979) (Fig.2). The Hino and Oanayama Conglomerate Members which are corresponded to the Hosogai Member cropout in the Oanayama area of the southern part of the Omine Belt.

The upper member of the Otari Formation is composed mainly of andesitic pyroclastic rocks and lava flow deposits. Thickness of the member attains to 1,500m.

The Omine Formation is distributed extensively in the central part of the Omine Belt. The Lower Member of the Omine Formation consists mainly of alternating beds of granule to pebble conglomerate and mudstone. Total thickness is about 600m. The middle Member of the Omine Formation is composed mainly of boulder conglomerate, sandstone, mudstone and acidic tuff beds. The muximum thickness of the member attains to 2,000m. The Upper Member of the Omine Formation mostly comprises acidic tuff beds. Tuff beds show frequently dense welded structures. K-Ar radiometric ages of 2.0±0.2 and 2.4±0.2Ma are reported (Yamada et al., 1985a). Another radiometric age dated by the fission track method are reported (Machida et al., 1997).

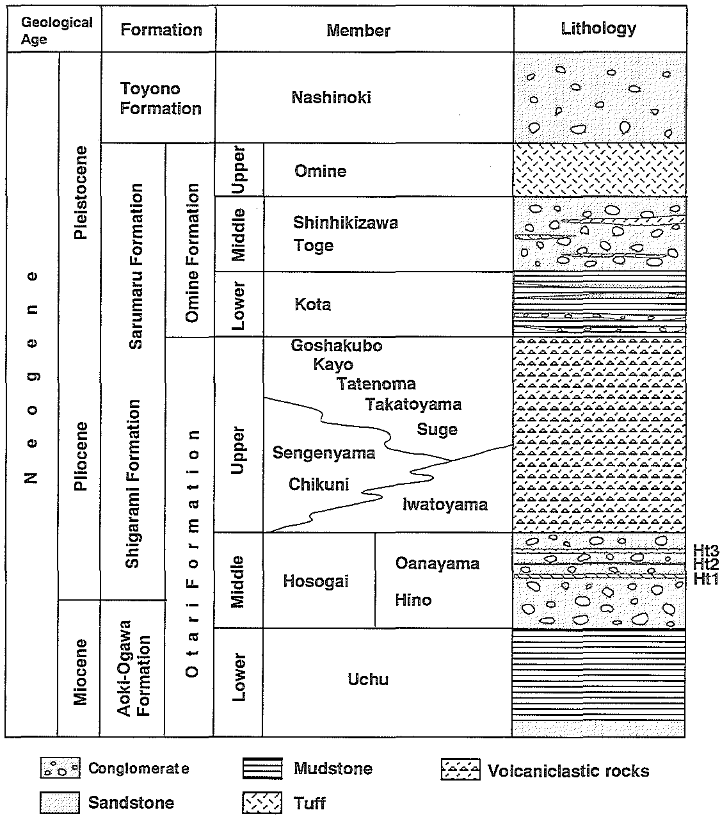


Fig.2 Plio-Pleistocene stratigraphy of the Omine Belt (modified from Kosaka, 1991).

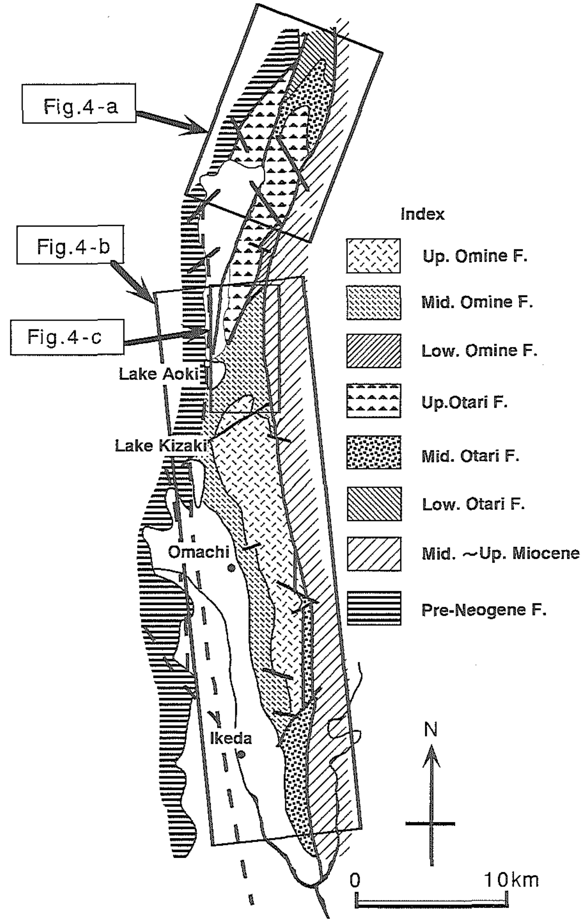


Fig.3 Geological map of the Omine Belt (modified from Kosaka, 1991).

The main provenance of these coarse-grained clastic sediments of the Omine Formation may existed in the Hida Mountains, western area of the Omine Belt (Kosaka, 1983; Kosaka, 1991).

Volcaniclastic sediments of the Omine Belt

Methods

Lithology and petrographic properties of the acidc volcaniclastic sediments in the Omine Belt were studied in detail. Each volcaniclastic sediment was examined in the following methods.

Lithofacies of the acidic volcaniclastic sediments was divided into four lithofacies types in the field i.e.

1) Pm-type: ill-sorted pumiceous facies in which pumiceous and lithic fragment are dotted
2) G-type: tuffaceous facies which is composed mainly of vitric ash
3) S-type: sandy facies
4) WT-type: welded tuff

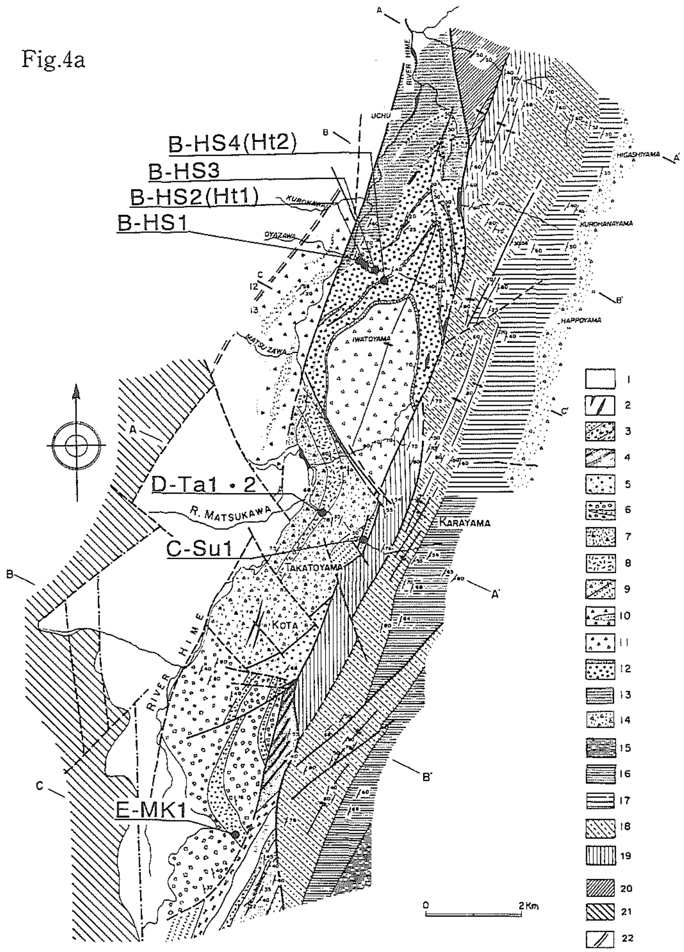
Samples of about 500g in weight were collected from various horizons of the Otari and Omine Formations in the field as shown in Figs.4 and 5.

Petrographic properties such as a grain composition, shape and refractive index of glass shards and heavy mineral composition were analized in the laboratory.

Approximately 200g of the samples were wet-sieved by a 250 meshes (1/16mm) Tailor's sieve. Particles in the sieve were cleaned by an ultrasonic cleaner and dried up, and then sieved by a 60 meshes sieve (1/4mm). Heavy minerals between 1/4 and 1/16mm were separated by ethanol solution of bromoform with a specific gravitiy of 2.85. Mineral particles between 1/4 and 1/16mm in size were sieved with Canada balsam on glass slides. Under a microscope, both of light and heavy mineral compositions were determined using more than 200 grains of glass, plagioclase, quartz and heavy minerals.

The heavy minerals were counted to determine the grain percentage of hornblende, orthopyroxene, clinopyroxene, biotite, zircon, apatite and opaque minerals. Shape and refractive index of glass shads were also studied. Generally volcanic ashes contain a great variety of shard morphologies ranging from bubble wall shards to pumiceous fragments (Ross, 1928). Yoshikawa (1976) described that glass shards are divided into three principal types. The first type consists of the wall of relatively large broken bubbles (called H-type shards). Second type, containing numerous small bubbles enclosed in glass, in fibrous and represents pumice fragments (called T-type shards). The third type is an intermediate form between the H-type and T-type shards (called

Fig.4a



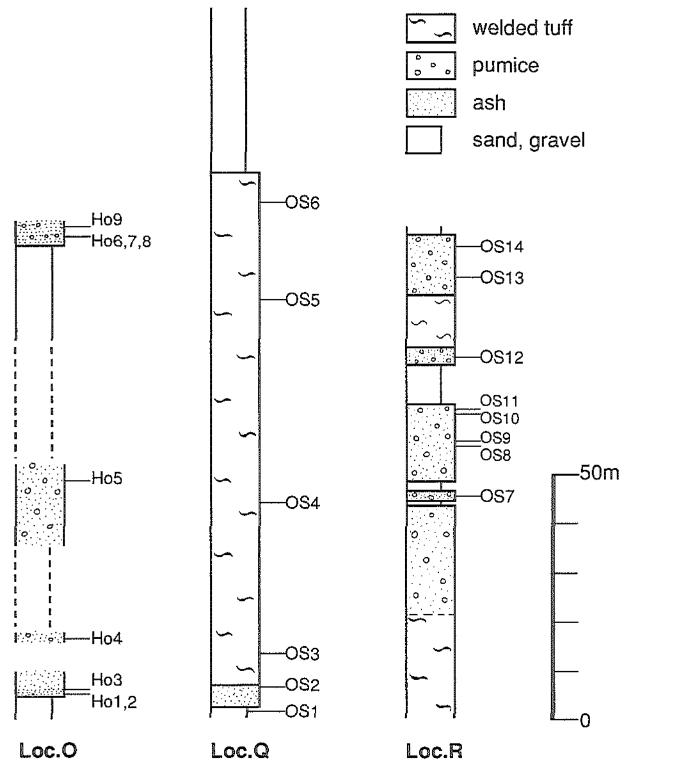


Fig.5 Columnar sections of the middle～upper horizon of the Omine Formation.

Loc.O: east of Horinouchi Ikedamachi, Loc.Q: west Aokidaira, Omachi City, Loc.R: bore hole section of west Aokidaira, Omachi City.

Fig.4b

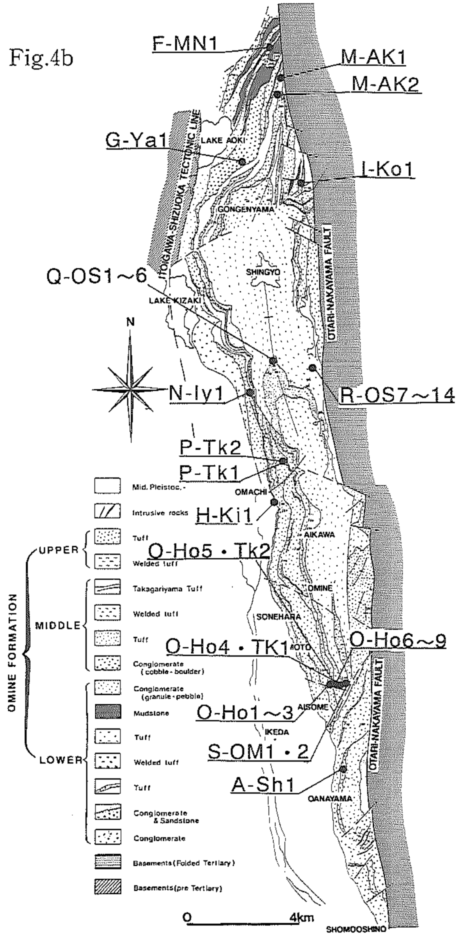


Fig.4c

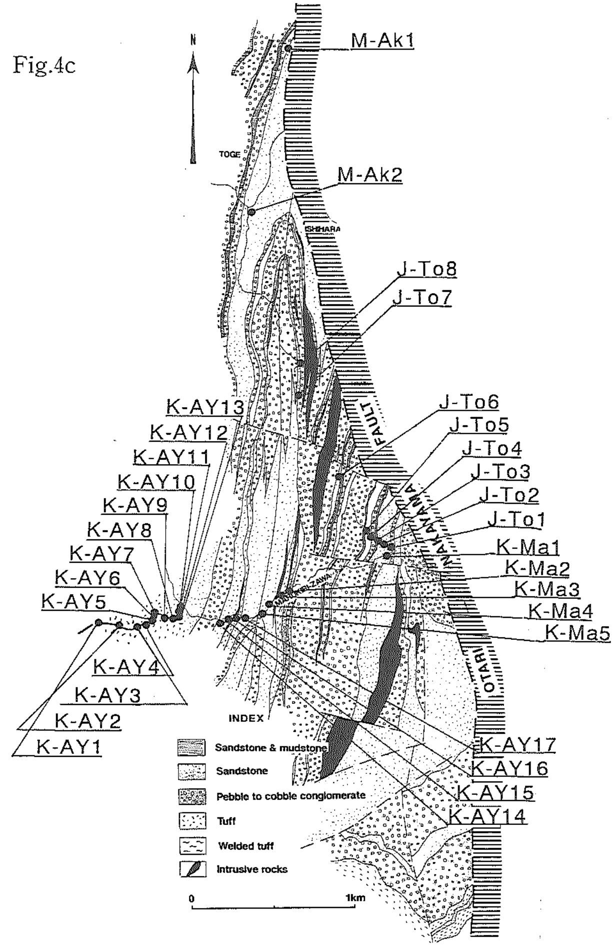


Fig.4a～c Map showing sampling localities of volcaniclastic sediments in the Omine Belt. Each map based on the data of Kosaka et al. (1979), Kosaka・Arai (1982) and Kosaka (1991).

C-type shards). On the basis of this classification, the grain percentage of the H-, T- and C-type shards were determined.

Refractive index of glass shards was measured by the dispersion coloration technique of Yoshikawa (1984).

Description of acidic volcaniclastic sediments

In this paper, 73 important volcaniclastic sediments obtained from the Otari and Omine Formations are described in detail. Sampling localities are shown in Fig.4a～c. The petrographic properties of these sediments are summarised in table 1.

Middle member of the Otari Formation

Volcaniclastic sediments of the middle member of the Otari Formation has biotite -dominant heavy mineral composition (B-HS1, B-HS2, B-HS3). The intercalated welded tuff (B-HS4) also is biotite-dominant and contain small amounts of hornblende, orthopyroxene and opaque minerals.

Three remarkable acidic tuff layers, i.e. Ht1, Ht2 and Ht3 were intercalated in the Hosogai member of the Otari Formation (Kosaka et al., 1979). Four samples are collected from these marker beds and described in detail.

B-HS1: The lithofacies of B-HS1 is S-type. This is composed mainly of volcanic glass in grain and mineral compositions. Heavy mineral is rare.

B-HS2: B-HS2 is collected at the horizon of the Ht1 tuff bed. The lithofacies is Pm-type. Lithic fragments and minerals are abundant in grain and mineral compositions. Biotite is abundant. Hornblende is common. Zircon and opaque minerals are rare.

B-HS3: B-HS3 is collected at the horizon of the Ht1 tuff bed. Lithofacies is G-type. Lithic fragments are abondant in a grain composition. Biotite and opaque minerals are dominant. Orthopyroxene is common. Hornblende, clinopyroxene, zircon and apatite are rare.

B-HS4: B-HS4 occurred in the middle horizon of the Ht2 tuff. Lithofacies is WT-type. Lithic fragments are abondant in a grain composition. Biotite, hornblende and opaque minerals are abundant in a heavy mineral composition. Orthopyroxene and apatite are rare.

A-Sh1: A-Sh1 is so-called the Shimekake Tuff (Himekawa Collabolative Research Group, 1958) of the Otari Formation. Lithofacies is Pm-type. Lithic fragments are common and volcanic glasses are rare in a grain composition. Opaque minerals and orthopyroxene are dominant, and hornblende and zircon are common. Clinopyroxene is rare.

Upper member of the Otari Formation

Major part of the upper member of the Otari Formation contains orthopyroxene minerals dominantly in its heavy mineral content (C-Su1, D-Ta1・2), but the welded tuff (E-MK1) from east of Kamishiro of Hakuba Village dominantly contains biotite.

C-Su1 : C-Su1 occurred in the upper horizon of the Suge Tuff (Kosaka and Arai, 1982) of the Otari Formation. Lithofacies is Pm-type. Volcanic glasses (C-type of glass shard) and lithic fragment are common in a grain compositions. Orthopyroxene, opaque minerals, hornblende and biotite are common in a heavy mineral compositions. Apatite is rare.

D-Ta1, 2 : D-Ta1, 2 are collected at the middle horizon of the Tatenoma Tuff and Conglomerate Bed (Kosaka and Arai, 1982) of the Otari Formation. Muddy or sandy tuffaceous facies are common in the Tatenoma Tuff and Conglomerate Bed.

Lower member of the Omine Formation

There is only one analyzed sample (F-MN1) from the lower member of the Omine Formation.

F-MN1 : Lithfacies is Pm-type. Volcanic glasses and minerals are common in grain compositions. Biotite and hornblende are abundant. Opaque mineral and orthopyroxene are common. Oxyhornblende and clinopyroxene are rare.

Middle member of the Omine Formation

Samples (locality symbols G・I・J・K・M) collected from the middle member of the Omine Formation near the border of northern Omachi City and Miasa Village consist mainly of biotite and hornblende in a heavy mineral composition. Some of them are orthopyroxene-dominant, but they contain about 10% of hornblende. Welded tuff contain over 70% of biotite in its heavy mineral content. The welded tuff from Teikouji of Omachi City has opaque-dominant heavy mineral content with some biotite and orthopyroxene minerals. In the southern part of the Omine Belt, the Takagariyama Tuff I・II and the tuff 50m above are almost devoid of biotite and hornblende and are orthopyroxene-dominant with some content of clinopyroxene and opaque minerals. Columnar sections are shown by Fig.5

M-AK1 : Lithofacies is S-type. Minerals and lithic fragments are common in grain compositions. Hornblende, biotite and opaque minerals are common. Orthopyroxene are rare.

M-AK2 : Lithofacies is Pm-type. Volcanic glasses are abundant and a small amount of lithic fragments occur in grain compositions. Volcanic glasses consist mainly of H, C -types with index of 1.499-1.502. In the heavy mineral composition, hornblende are common, oxyhornblende and clinopyroxene are rare. Zircon is traceable.

J-To1, 2: Lithofacies is Pm-type. Volcanic glasses which consist mainly of H-type with index of 1.500-1.501 are abundant in grain composition. Opaque mineral are common, hornblende and orthopyroxene are rare. Zircon is traceable.

J-To3: Lithofacies is WT-type. Litic fragments are abundant in grain composition. Biotite is abundant. Opaque mineral, orthopyroxene and clinopyroxene are rare.

J-To4: Lithofacies is S-type. Lithic fragments and minerals are common in the grain composition. Opaque minerals are abundant. Biotite, hornblende, orthopyroxene, zircon and apatite are rare.

J-To5: Lithofacies is S-type. Minerals and lithic fragments are abundant. Opaque minerals are dominant. Hornblende is common. Zircon is rare.

J-To6: Lithofacies is S-type. Minerals are dominant in grain composition. Biotite is dominant. Hornblende and opaque mineral are rare.

J-To7, 8: Lithofacies are Pm-type. Volcanic glasses which consist mainly of C-type shards with index of 1.500-1.503 are abundant in grain composition. Opaque mineral is dominant. Biotite and hornblende are common. Orthopyroxene, allanite, zircon and apatite are rare.

G-Ya1: Lithofacies is WT-type. Lithic fragments and volcanic glasses which consist mainly of C-type shards are abundant in grain composition. Biotite is dominant. Orthopyroxene is rare.

K-AY1: Lithofacies is G-type. Lithic fragments and minerals are dominant in grain compositions. Opaque minerala are dominant. Biotite and hornblende are common. Orthopyroxene and zircon are rare.

K-AY2: Lithofacies is G-type. Volcanic glass particles consist mainly of H,C-type with index of 1.497-1.499. Biotite is dominant. Opaque mineral and orthopyroxene are rare. Hornblende is traceable.

K-AY3~13: Lithofacies is Pm-type without of AY-11. Volcanic glass particles consist mainly of H, C-types with index of 1.497-1.503. Opaque minerals, orthopyroxene and hornblende are dominant. Clinopyroxene and zircon are rare. Biotite is traceable. Some samples contain orthopyroxene, zircon and apatite. K-AY6 contain 21% zircon abundantly in a heavy mineral composition.

K-AY14: Lithofacies is Pm-type. Lithic fragments are dominant in a grain composition. Biotite and opaque minerala are dominant. Orthopyroxene and zircon are rare.

K-AY15, 16: Lithofacies is WT-type. H-type glasses and lithic fragments are dominant in a grain composition. Biotite is dominant and opaque minerals are common. Hornblende and orthopyroxene are rare.

K-AY17: Lithofacies is Pm-type. Volcanic glasses which consist of H-type glass particles with index of 1.495-1.498 are dominant in grain composition. Biotite is abundant. Zircon is traceable.

K-Ma1: Lithofacies is G-type. Volcanic glass particles consist mainly of H-type shards with index of 1.500-1.501. Opaque minerals is common. Hornblende and zircon are rare. Clinopyroxene is traceable.

K-Ma2: Lithofacies is Pm-type. Volcanic glasse particles which consist mainly of H-type shards with index of 1.496-1.497 are dominant in grain composition. Biotite is dominant and opaque minerals are rare.

K-Ma3: Lithofacies is WT-type. Lithic fragments are dominant in a grain composition. Biotite is dominant. Orthopyroxene and opaque minerals are rare.

K-Ma4, 5: Lithofacies is Pm-type. Volcanic grlass particles which consist mainly of H-type with index of 1.496-1.497 are dominant in a grain composition. Biotite and opaque minerals are dominant in a heavy mineral composition. Orthopyroxene and zircon are rare.

I-Ko1: Lithofacies is G-type.Volcanic glass particles which consist mainly of H-type with index of 1.499-1.500 are dominant in a grain composition. Opaque minerals are dominant. Orthopyroxene and hornblende are common. Clinopyroxene and zircon are rare.

N-Iy1: Lithofacies is WT-type. Lithic fragments and minerals are dominant in a grain composition. Opaque minerals are dominant. Biotite and orthopyroxene are common. Hornblende and clinopyroxene are rare. Zircon is traceable.

O-Ho1, 2, 3: These three samples are collected from the lower horizon of the Tkagari-yama Tuff I (Nagahashi et al. 1996). Lithofacies is S-type. Volcanic glass particles which consist mainly of H, C-type with index of 1.497-1.500 are dominant in a grain composition. Orthopyroxene is dominant. Clinopyroxene and opaque minerala are common. Hornblende is rare.

O-Ho4, TK1: These two samples are collected from the upper horizon of the Tkagari-yama Tuff I. Minerals and volcanic glasses which consist mainly of H-type with index of 1.500-1.501 are dominant in a grain composition. Glass index of TK1 is a little lower than the Ho4. Orthopyroxene is dominant. Clinoryroxene and opaque minerals are common. Hornblende is rare.

O-Ho5, TK2: These two samples are collected from the upper horizon of the Tkagari-yama Tuff II (Nagahashi et al. 1996). Lithofacies is Pm-type. Volcanic glasse particles which consist mainly of C-type with index of 1.500-1.501 are dominant. Orthopyroxene and opaque minerals are dominant. Hornblende and clinopyroxene are rare.

O-Ho6～9: Lithofacies is Pm-type. In a grain composition, minerals are dominant and volcanic glasses which consist mainly of C-type are common. Orthopyroxene are dominant. Clinopyroxene and opaque minerala are common. Hornblende and zircon are rare.

Upper member of the Omine Formation

The welded tuff collected from the upper member of the Omine Formation (S-OM1, 2), east of Horinouchi Ikeda Town, has biotite・opaque-dominant heavy mineral composition with some orthopyroxene and hornblende. Welded tuff confirmed by drilling at a site west of Aokidaira of Omachi City also has similar heavy mineral characteristics. Although biotite-dominant, the above rocks can be distinguished from other welded tuffs (those in units below the middle member of the Omine Formation) by the content of 10～20% of orthopyroxene. The above drilled sample, could belong to the middle member of the Omine Formation because of its lithology and the heavy mineral content.

S-OM1 : This sample is collected from the non-welded horizon of the upper member of the Omine Formation. Lithofacies is Pm-type. Volcanic glass particles which consist mainly of H-type with index of 1.498-1.499 are dominant. Biotite and opaque minerals are dominant. Orthopyroxene is common. Hornblende and zircon are rare.
S-OM2 : This sample is collected from the welded horizon of the upper member of the Omine Formation. In a grain composition, lithic fragments are dominant. Volcanic glass particles which consist mainly of C-type with index of 1.50-1.502 are common. Biotite and opaque minerals are dominant. Orthopyroxene is common. Zircon is rare. Hornblende is traceable.
Q-OS1 : Lithofacies is S-type. Minerals are dominant in the grain composition. Opaque minerals are dominant in a heavy mineral composition. Hornblende is common. Biotite is rare. Orthopyroxene and zircon are traceable.
Q-OS2 : Lithofacies is S-type. Volcanic glass particles of H, C-type are dominant. Biotite, orthopyroxene and opaque minerals are dominant in a heavy mineral composition. Apatite and zircon are rare. Hornblende is traceable.
Q-OS3～6 : Lithofacies is WT-type. In the grain composition, lithic fragments are dominant. In a basal part of these samples, volcanic glasses of H-type are dominant. Biotite, opaque minerals and orthopyroxene are dominant in a heavy mineral composition. Hornblende and opaque minerals are common. Orthopyroxene is rare. Zircon, apatite and clinopyroxene are traceable.
R-OS8～10 : Lithofacies is Pm-type. Volcanic glasses which consist mainly of C-type with index of 1.498-1.500 are dominant. Hornblende and orthopyroxene are dominant. Biotite and opaque minerals are common. Zircon, clinopyroxene and apatite are traceable.
R-OS11 : Lithofacies is S-type. Volcanic glasses which consist mainly of H, C-type with index of 1.488-1.500 are dominant in a grain composition. Hornblende is dominant. Orthopyroxene and opaque minerals are common. Biotite is rare. Zircon is traceable.

R-OS12: Lithofacies is Pm-type. Volcanic glasses which consist mainly of C-type are dominant in a grain composition. Hornblende is dominant. Orthopyroxene and opaque minerals is common. Zircon is rare. Biotite and clinopyroxene are traceable.
R-OS13, 14: Lithofacies of OS13 is Pm-type and OS14 is G-type. Volcanic glasse which consist mainly of H, C-type with index of 1.497-1.500 are dominant. Orthopyroxene is common. Zircon is rare. Hornblende, clinopyroxene and biotite are traceable.

Discussions

Shape, refractive indices of volcanic glasses and heavy mineral compositions

The ratio of volcanic glass (Gl), feldspar + quartz (Fl+Qz) and heavy mineral (H. M.) are shown by lithological type in Fig.6. The ratio of H-type, C- and T-type glasses are shown by lithological type in Fig.7. Pm-type sediments are rich in H-type and C-type volcanic glasses. G-type sediments are rich in C-type volcanic glasses. S-type sediments also rich in H-type and C-type volcanic glasses.

The refractive indices of volcanic glasses ranging from n=1.495 to 1.506 (Table 1). Glasses of samples O-Ho6・7・8 of the Takagariyama Tuff II have relatively high refractive index range of n=1.503~1.506. Most of other glasses has an index range and a mode value of lower than n=1.500. The volcanic glasses of the Omine Belt are

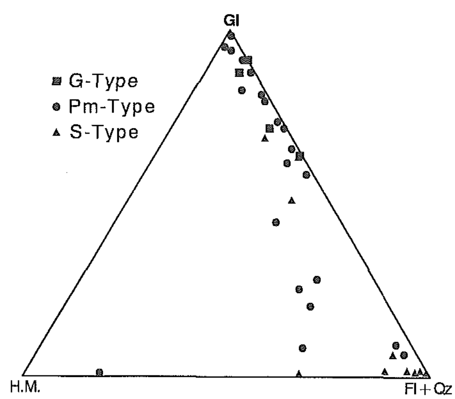


Fig.6 Grain composition. Modal composition of Gl(volcanic glass), Fl+Qz(plagioclase + quartz) and H.M.(heavy mineral) are plotted.

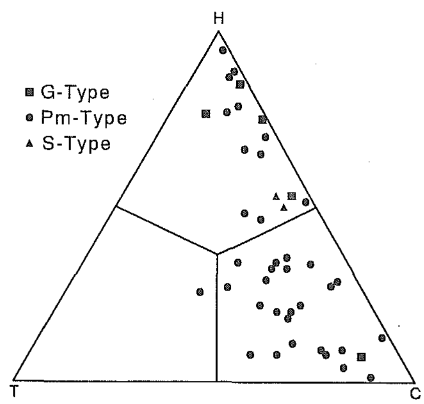


Fig.7 Shape of volcanic glasses in volcaniclastic sediments.
Modal composition of H (Ha+Hb), C (Ca+Cb) and T (Ta+Tb) type are plotted.
Pm: pumice type, G: glassy type, S: sandy type, WT: welded tuff type, Gl: volcanic glass, Fl: feldspar, Qz: quartz, Hm: heavy mineral, Ha+Hb: flat type, Ta+Tb: porous type, Ca+Cb: medium type

Table 1 Petrographic properties of the volcaniclastic sediments of the Omine Belt.

Stratigraphic division	Facies type	Loc.	Sp. No.	Grain component				Glass							Heavy mineral composition										
				Gl.	F+Q	Hm.	Ot.	Ha	Hb	Ca	Cb	Ta	Tb	Index = n (mode)	Bi.	Ho.	oxHo.	Opx.	Cpx.	Ga.	All.	Zi.	Ap.	Opq.	Total
Omine Formation Upper	WT	S	OM2	12	9	2	77	0	14	50	8	21	7	1.500-1.502(1.5010)	55	*	0	11	0	0	0	1	0	33	
	Pm	S	OM1	96	*	1	2	10	56	12	15	4	3	1.498-1.499(1.4985)	47	2	0	10	0	0	0	5	0	36	
Omine Formation Upper?	G	R	OS14	92	5	0	3	1	53	15	26	1	4	1.498-1.499	*	3	0	16	3	0	0	8	0	69	
	Pm	R	OS13	88	6	1	5	7	44	28	18	2	*	1.497-1.500(1.4990)	1	3	0	6	0	0	0	5	0	85	
	Pm	R	OS12	92	3	*	4	4	29	19	28	9	11		*	69	0	13	*	0	0	6	0	11	
	S	R	OS11	64	24	7	5	3	48	14	26	2	7	1.498-1.500	7	52	0	19	0	0	0	5	0	17	
	Pm	R	OS10	93	2	4	*	1	7	21	33	22	16	1.498-1.500	38	45	0	10	*	0	0	3	*	2	
	Pm	R	OS9	78	12	6	4	0	27	10	29	18	16	1.498-1.499	7	46	0	20	1	0	0	*	0	25	
	Pm	R	OS8	93	3	3	1	2	17	30	28	12	11	1.498-1.499	16	39	0	15	0	0	0	8	2	20	
	Pm	R	OS7	93	3	3	1	1	4	14	65	3	13	1.498-1.500	53	18	0	7	*	0	0	1	1	19	
Omine Formation Upper	WT	Q	OS6	*	12	4	83								40	*	0	1	0	0	0	*	0	58	
	WT	Q	OS5	0	16	5	79								29	3	0	13	*	0	0	1	0	53	
	WT	Q	OS4	*	12	4	83								31	*	0	28	*	0	0	*	0	39	
	WT	Q	OS3	92	3	3	2	12	86	2	0	0	0		43	4	0	22	0	0	0	2	2	27	
	S	Q	OS2	95	2	2	1	5	49	30	7	9	0		45	*	0	22	0	0	0	4	6	22	
	S	Q	OS1	*	70	3	26								8	14	0	2	0	0	0	5	0	71	
Omine Formation Middle	Pm	P	TK2	91	5	1	3	7	28	13	24	13	15	1.500-1.502(1.5010)	0	*	0	38	7	0	0	1	0	53	
	G	P	TK1	61	22	4	13	11	66	5	3	13	2	1.496-1.498(1.4970)	0	0	0	50	12	0	0	*	0	38	
	Pm	O	Ho9	7	66	3	24	0	3	74	12	8	3		0	*	0	82	7	0	0	*	0	9	
	Pm	O	Ho8	21	47	17	15	0	11	68	7	12	2	1.503-1.505(1.5040)	0	0	0	80	5	0	0	0	0	15	
	G	O	Ho7	57	33	*	9	*	8	67	14	7	3	1.503-1.506(1.5045)	0	0	0	69	7	0	0	0	0	24	
	Pm	O	Ho6	21	44	11	24	0	9	58	14	14	5	1.503-1.504	0	0	0	80	10	0	0	0	0	10	
	Pm	O	Ho5	93	6	1	0	1	7	32	29	14	17	1.500-1.501(1.5005)	0	4	0	35	3	0	0	0	0	58	
	Pm	O	Ho4	39	36	15	9	10	26	40	8	13	3	1.500-1.501(1.5005)	0	*	0	69	17	0	0	0	0	13	
	S	O	Ho3	91	5	*	3	36	53	8	1	1	1	1.497-1.499(1.4980)	0	1	0	55	7	0	0	*	0	36	
	S	O	Ho2	44	35	8	13	5	44	33	14	3	*	1.499-1.500(1.5000)	0	1	0	77	11	0	0	0	0	11	
	Pm	O	Ho1	7	57	25	11	0	13	62	0	21	4		0	0	0	73	12	0	0	0	0	15	
	S	N	Iy1	2	26	2	70								60	11	0	3	0	0	0	1	0	25	
	Pm	M	AK2	61	2	*	36	1	33	44	12	8	2	1.499-1.502	16	47	2	12	1	0	0	4	0	18	133
	S	M	AK1	*	47	6	46								25	54	0	0	1	0	0	0	0	20	76
	Pm	K	AY17	91	1	1	7	12	66	6	7	2	7	1.495-1.498(1.4965)	99	0	0	0	0	0	0	*	0	0	62
	WT	K	AY16	62	3	1	33	9	82	7	*	1	0		88	1	0	3	0	0	0	0	0	8	68
	WT	K	AY15	49	3	*	47	2	61	21	2	11	3		87	0	0	0	0	0	0	0	0	13	72
	Pm	K	AY14	1	3	*	95								72	0	0	4	0	1	0	0	0	23	79
	Pm	K	AY13	40	9	1	50	2	11	81	4	1	*	1.498-1.500(1.4990)	2	73	2	6	0	0	0	*	0	17	
	Pm	K	AY12	37	13	*	49	5	24	56	9	5	*	1.499-1.503	*	27	*	9	*	0	0	*	0	62	
	S	K	AY11	37	21	*	41	3	52	40	1	3	1	1.497-1.499	0	30	0	4	4	0	0	*	0	61	
	Pm	K	AY10	84	6	*	9	2	26	41	23	5	3	1.500-1.502	1	12	0	17	5	0	0	1	0	64	

Stratigraphic division	Facies type	Loc.	Sp. No.	Grain component				Glass							Heavy mineral composition										
				Gl.	F+Q	Hm.	Ot.	Ha	Hb	Ca	Cb	Ta	Tb	Index = n (mode)	Bi.	Ho.	oxHo.	Opx.	Cpx.	Ga.	All.	Zi.	Ap.	Opq.	Total
	Pm	K	AY9	87	5	*	7	*	22	35	24	13	5	1.500-1.502	0	16	0	23	1	0	0	1	0	59	
	Pm	K	AY8	89	3	*	7	2	45	26	11	8	8	1.501-1.503	0	7	0	10	3	*	0	*	0	79	
	Pm	K	AY7	72	5	*	22	0	33	37	14	8	8	1.498-1.500	1	11	*	49	0	1	0	1	0	36	
	Pm	K	AY6	71	10	*	18	6	56	25	9	2	2	1.500-1.502	1	7	0	32	0	21	0	11	1	27	81
	Pm	K	AY5	58	14	*	27	3	64	19	4	9	1	1.500-1.502(1.5015)	*	15	0	34	1	0	0	1	0	48	
	Pm	K	AY4	80	11	*	8	1	34	36	11	13	5	1.501-1.503	0	10	0	30	2	1	0	1	0	56	
	Pm	K	AY3	57	5	*	37	1	48	20	11	14	6	1.501-1.502	0	11	0	11	*	0	0	*	0	76	
	G	K	AY2	86	9	4	1	11	42	35	11	1	0	1.497-1.499	94	*	0	1	0	0	0	0	0	4	
	S	K	AY1	*	55	3	41								17	9	0	2	0	0	0	4	0	68	
	Pm	K	Ma5	0	2	2	96								39	28	0	3	0	0	0	0	0	30	84
	Pm	K	Ma4	78	1	*	20	15	72	7	2	3	*	1.496-1.497	70	13	0	2	0	0	0	*	0	14	
	WT	K	Ma3	25	0	*	74	7	50	17	2	20	4		94	0	0	5	0	0	0	0	0	1	63
Omine Formation Middle	Pm	K	Ma2	96	2	*	1	43	36	5	10	2	4	1.496-1.497	90	3	0	0	0	0	0	0	0	7	74
	G	K	Ma1	87	9	*	3	14	72	6	6	1	*	1.500-1.501	0	3	0	13	*	0	0	3	0	80	
	Pm	J	To8	82	6	*	11	0	36	33	15	9	7	1.501-1.502	10	18	0	5	0	0	*	*	0	66	
	Pm	J	To7	89	5	*	5	1	20	34	20	17	8	1.500-1.503	0	6	0	9	0	0	0	1	*	83	
	S	J	To6	1	57	27	15								82	15	0	0	0	0	0	0	0	3	
	S	J	To5	0	66	*	34								0	14	0	0	0	0	0	1	0	85	77
	S	J	To4	*	46	*	52								4	1	0	1	0	0	0	1	2	91	
	WT	J	To3	0	14	*	85								73	0	0	1	1	0	0	0	0	25	91
	Pm	J	To2	89	3	*	7	24	65	6	3	1	*	1.500-1.501	0	1	0	3	0	0	0	4	0	92	
	Pm	J	To1	84	8	*	7	27	68	2	2	0	*	1.500-1.501	0	3	0	5	0	0	0	5	0	87	
	G	I	Ko1	91	4	*	4	16	60	10	12	*	*	1.499-1.500	0	9	0	15	1	0	0	1	0	74	
	Pm	H	Ki1	2	24	1	73								11	1	0	13	1	0	0	*	0	73	
	WT	G	Ya1	35	16	*	48	0	9	66	21	4	0	1.497-1.499	88	0	0	9	0	0	0	*	0	2	
Omine F. Lower	Pm	F	MN1	62	25	1	12	1	20	34	23	11	11	1.498-1.500	27	52	*	9	*	0	0	0	0	10	
	WT	E	MK1	0	17	4	79								96	0	0	0	0	0	0	0	0	4	
Otari Formation Upper	Pm	D	Ta2	33	17	*	49	0	26	24	9	32	9	1.498-1.500	1	1	0	65	2	0	0	*	*	30	
	Pm	D	Ta1	30	21	*	49	1	29	37	10	21	2	1.498-1.499	3	7	0	60	3	0	0	*	1	25	
	Pm	C	Su1	77	3	3	17	4	17	28	22	11	18	1.496-1.498	15	17	0	32	2	0	0	1	*	32	
	WT	B	HS4	0	4	*	95								65	13	0	5	0	0	0	0	*	16	62
Otari Formation Middle	G	B	HS3	0	1	*	98								31	3	0	13	2	0	0	2	*	48	
	Pm	B	HS2	0	8	35	57								85	13	0	0	0	0	0	*	0	1	
	S	B	HS1	81	11	1	7																		
	Pm	A	Sh1	11	6	*	82	5	65	23	3	2	*		0	10	0	33	3	0	0	7	0	47	

divided into two groups in indices properties. Index of the higher group ranges from n=1.499 to 1.502. A lower group ranges from n=1.495 to 1.499 (Table 1).

Volcaniclastic sediments of the Omine Belt contain relatively high contents of heavy minerals such as a biotite, hornblende, orthopyroxene, and opaque minerals. Most of the samples analyzed are plotted on the rhyolitic area and on the hornblende dacite area of the BHC diagram which was proposed by Kurokawa and Sawakuri(1984)(Fig. 8). All of the welded tuff samples particularly are rich in the biotite + allanite + zircon. These samples were also plotted on a triangular diagram of the three major components of biotite, hornblende and clinopyroxene (Fig.9).

All samples contain biotite in varying amounts. The Takagariyama Tuff I contains clinopyroxene over 10% (O-Ho1 • 2 • 3 • 4, P-TK1). The sample K-AY6 of the middle member of the Omine Formation contains 21% zircon. These samples show a great difference with another tuff beds of the Omine Belt.

Provenance of acidic pyroclastic sediments of the Omine Belt

Most of the volcanic rocks of the Otari Formation are andesitic volcaniclastic deposits, lava flow deposits and intrusive rocks (Kosaka et al., 1979; Kosaka and Arai, 1982). Acidic tuffs occur in the Hosogai and Oanayama Member of the Otari Formation (Ht-1~3, A-Sh1). The upper member of the Otari Formation and the lower member of the Omine Formations has an alternating beds of andesitic and dacitic

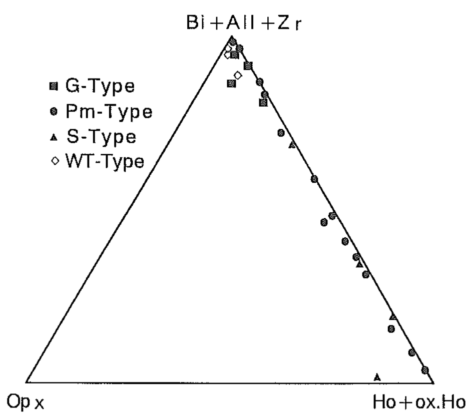


Fig.8 BHC diagram (by Kurokawa and Sawaguri, 1986) of volcaniclastic sediments of the Omine Belt.

Bi : biotite, Ho: hornblende, oxHo: oxyhornblende, Opx : orthopyroxene, Cpx: clinopyroxene, Ga: garnet, All: allanite, Zr: zircon, Ap: apatite, Opq: opaque mineral, *: less than 1%

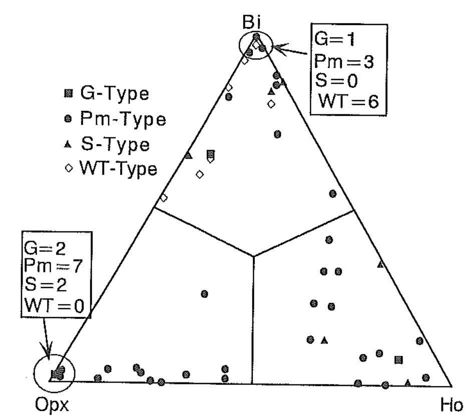


Fig.9. Modal composition of heavy minerals.

~rhyolitic volcaniclastic rocks. The middle to upper Omine Formation, although, composed abundantly of acidic volcaniclastic sediments (Kosaka 1991).

There is no doubt that volcanic activities occurred within the Belt during the formation of the andesitic volcanic rocks and intrusive bodies of the Otari Formation from a viewpoint of their modes of occurrence (Kosaka and Arai, 1982). Kosaka (1991) have reported that all volcaniclastic sediments of the Omine Belt may be products of volcanic activities occurring within the Belt.

Pliocene~Pleistocene acidic volcaniclastic sediments distributed extensively in the Northern Japan Alps (Hida Mountains) located on the western side of the Omine Belt (Isomi and Nozawa, 1957; Kaneko et al., 1976; Saito et al., 1984; Yamada et al., 1985b; Harayama, 1990). Nagahashi (1995) clarified that the Nyukawa Pyroclastic Flow Deposits, Ebisutoge Pyroclastic Sediments and Kamitakara Pyroclastic Flow Deposits which are the Pliocene~middle Pleistocene pyroclastic sediments distributed in the vicinity of the Takayama Basin (Gifu Prefecture), can be divided into six units, namely TK-1~5. This grouping was made by the combination of the characteristics of heavy mineral compositions, refractive indices of the volcanic glasses and other relevant features.

The Takagariyama Tuff I of the Omine Belt and the Seba Pyroclastic Flow Deposit of the Matsumoto Basin can be correlated to the Nyukawa Pyroclastic Flow Deposit (TK-3) (Nagahashi et al., 1996). The Takagariyama Tuff II is the correlative with the Ebisutoge Pyroclastic Deposit (TK-4b) of the Takayama Basin (Nagahashi et al., 1996). The source area of the Nyukawa Pyroclastic Flow Deposit and its equivalent are considered to be Hotakadake area of the Northern Japan Alps (Harayama, 1992). Thus, it was clarified that not all of the pyroclastic sediments in the Omine Belt are the products of volcanic activities occurring within the Belt.

In the vicinity of the Takayama Basin, Obora Volcanic Ash Flow of the Ogaya Formation (Saito et al., 1984; Nagahashi, 1995) occurs as an acidic volcaniclastic sediment of a lower horizon than the Nyukawa Pyroclastic Flow Deposit. Pyroclastic sediments intercalated in the Obora Formation are poor in heavy minerals and contain minor amounts of amphibole, garnet, allanite, and zircon, and they are fine to medium-grained volcanic ash (Nagahashi, 1995). The Kamitakara Pyroclastic Flow Deposit which is an overlying volcaniclastic rocks of the Ebisutoge Pyroclastic Sediment shows a minor constituents of heavy minerals (Kaneko et al., 1976). The petrographic features of these pyroclastic sediments of the Takayama Basin differ from those of the Omine Belt intercalating in higher and lower horizons of the Takagariyama Tuff. Thus the Nyukawa Pyroclastic Flow Deposit and the Ebisutoge Pyroclastic Sediments are the only two units closely related to the Omine Belt among the acidic pyroclastic material in the vicinity of the Takayama Basin.

The fact indicates that even a part of the acidic pyroclastic flow deposits within the

Omine Belt has its provenance outside of the Belt, particularly in the Northern Japan Alps area. It is necessary to consider the origin of other vast volcanic ejecta not limited to the inner side of the Belt, but expand it to the Northern Japan Alps in the west. Ishizawa (1982) reported on the occurrence of Shirasawa Tengu Rhyolite (welded tuff) rich in mafic minerals such as olivine and pyroxene within Cretaceous～Paleogene igneous body in the vicinity of Kashima yarigatake～Eboshidake in the Northern Japan Alps, and mentions its relation to the welded tuff in the Omine Belt.

It is an important problem to meke clear whether volcanic activities were expanded widely within the Omine Belt and supplied the vast amount of acidic volcaniclastic materials to inner and outer side of the Belt or nor during Pliocene to early Pleistocene time.

Summary

In this study, lithofacies and petrographical features of the acidic pyroclastic sediments distributed in the Omine Belt were studied and the basic characteristics were clarified as follows. 1) Regarding lithofacies, the sediments consists mostly of pumiceous vitric volcanic ash and welded tuff. 2) Lithologically the sediments are inferred to be dacitic ～rhyolitic. 3) Welded tuff, particularly has biotite-dominant rhyolitic nature regardless of its stratigraphic position. 4) Takagariyama Tuff I・II and the pyroclastic sediments in approximately 50m higher horizon has unique heavy mineral composition of being orthopyroxene-dominant without biotite or hornblende. 5) Petrographically the Takagariyama Tuff I・II and the pyroclastic sediments in approximately 50 m higher horizon are correlated to the Nyukawa Pyroclastic Flow Deposit and the Ebisutoge Pyroclastic Sediments which occur in the vicinity of Takayama Basin to the west of the northern Japan Alps, and are pyroclastic flow deposits with source near the Hotakadake of northern Japan Alps. 6) The provenance of the vast amount of acidic pyroclastic sediments which are distributed in the Omine Belt is an important problem for future study.

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