Correlation of the early Pliocene Znp Tephra Bed to the Hjp Tephra Bed around Yoneyama in the Niigata region, central Japan

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Abstract

The early Pliocene Znp Tephra Bed is one of the prominent submarine tephra deposits in the Niigata region. The Znp Tephra Bed in the Nishiyama Oil Field was correlated to the Hjp Tephra Bed around Yoneyama on the lithology, pertrography and chemical composition of glass shards. The Znp and the Hjp Tephra Beds contain abundant subangular fibrously vesiculated pumice clasts in common. In both Tephras, the shape of glass shards are characterized by bubble-junction type shards accompaning fibrously vesiculated shards. The glass shards show similar chemical composition in both Tephras, especially characterized by CaO contents of 0.52-0.58% in average. The locations of the Hjp Tephra Bed are situated about 40-45km southwestward toward the possible volcanic source area from the type locality of the Znp Tephra Bed at Yamada. In the Niigata region further toward the volcanic source area, the possibility of detection of the correlative tephra beds was also discussed.

Key words: Znp Tephra, Hjp Tephra, Ywg Tephra, submarine widespread tephra, bubble-junction glass shard, Pliocene, Yoneyama, Niigata

Introduction

The Znp Tephra Bed in the Niigata region is one of the prominent early Pliocene tephra deposits. It was correlated widely so as to the PM Tephra Bed around the Toyama Bay, the Ohta-Otani-Akogi Tephra Bed in the fluvio-lacustrine Tokai Group around the Ise Bay (Kurokawa and Tomita, 1998) and the HojiroII Tephra Bed in the fluvio-lacustrine Kobiwako Group (Yoshikawa, 2001) (Fig.1). On-land correlative pyroclastic flow deposit, namely the Nakatsugawa Tephra Bed, was also detected (Nakayama et al., 1994). In the Nishiyama Oil Field in the Niigata region, it attains to more than 6m in thickness (Figs.4,9), directly

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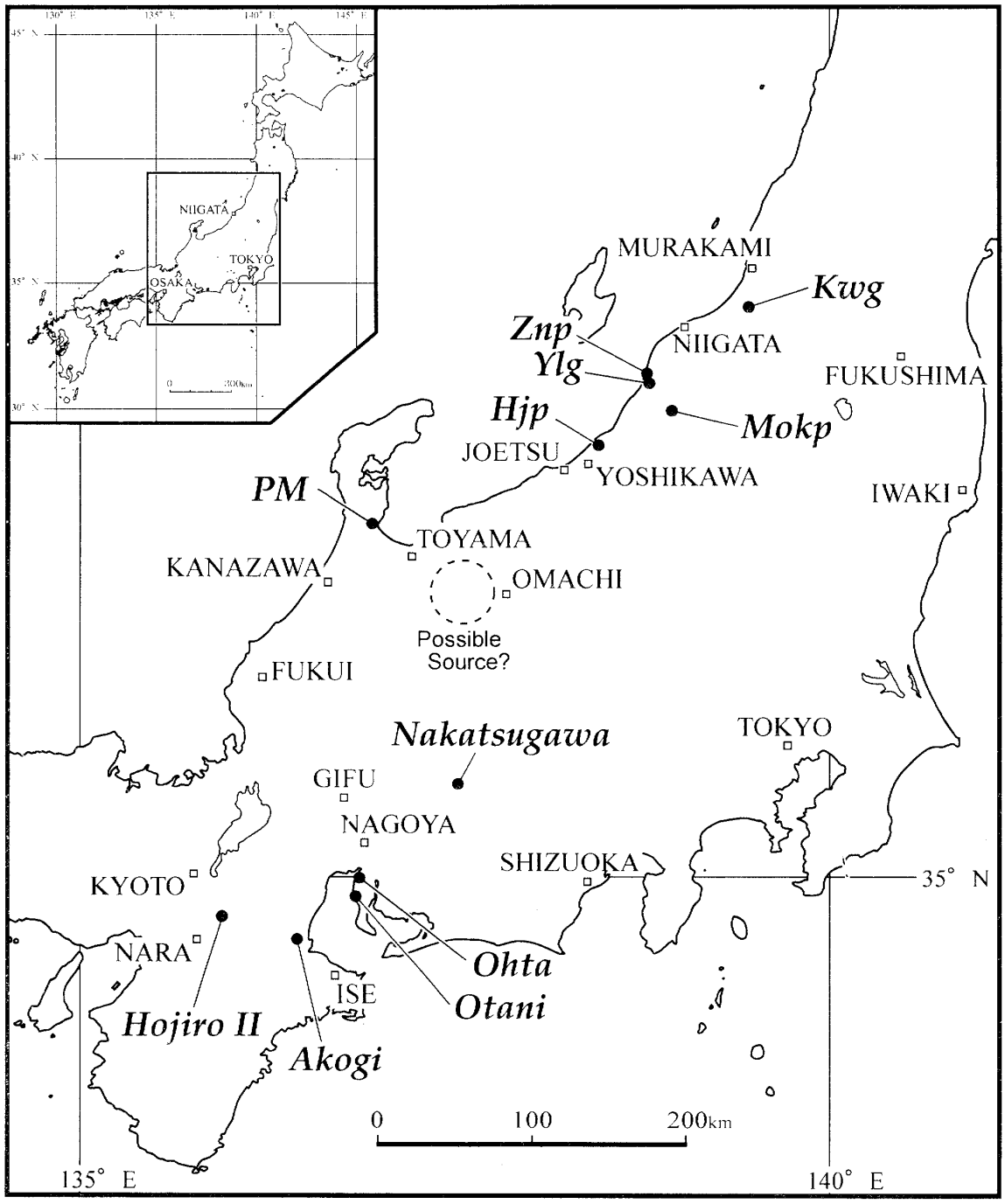

Fig.1. Locations of the Znp Tephra Bed in the Nishiyama Oil Field, the Hjp Tephra Bed in the Yoneyama area, the Kwg Tephra Bed in the Kitakanbara area, the Ylg Tephra Bed in the Chuo Oil Field and the Mokp Tephra Bed in the Higashiyama Hills. The correlative Tephra Bed in central Japan are also indicated, that is the PM Tephra Bed in the Himi Group, the Ohta-Otani-Akogi Tephra Bed in the Tokai Group, the HojiroII Tephra Bed in the Kobiwako Group. The Nakatsugawa Tephra Bed as on-land equivalent is also shown.

overlain by the Ywg Tephra Beds. The source volcanic field was supposed in the northern Chubu Mountains, about 160km southwest ward from the Nishiyama Oil Field.

In the Niigata region, the Znp Tephra Bed was so far correlated to the Ylg Tephra Bed in the Chuo Oil Field (Kurokawa et al., 1989), the Mokp Tephra Bed in the Higashiyama Hills of eastern Nagaoka City (Kurokawa et al., 2002) and the Kwg Tephra Bed in the Kuwae Formation in northern Shibata City (Kurokawa et al., 1999). But in the Niigata region, the correlation of the Znp Tephra Bed westward towards the possible source is not accomplished.

In this paper, we examined the correlation of the Znp Tephra Bed to the Hjp Tephra Bed around Yoneyama area, about 40-45km apart southwestwards from the type locality of the Znp Tephra Bed at Yamada, Teradomari Town, and about 110km apart from the possible volcanic source.

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the Hjp Tephra Bed

In the Yoneyama area, westward of Mt.Yoneyama, the Hijirigahana (Hjp) Tephra Bed is intercalated in the early Pliocene Hijirigahana Formation, composed of the alternation of turbidite sand and silt beds (Yoneyama Research Group, 1973; Takeuchi et al., 1996).

At the Cape Hijirigahana, the type locality of the Hjp Tephra Bed near JR Yoneyama station in Kashiwazaki City, it is about 250cm thick. At this locality, pumice clasts are abundant making lamination (Fig.5). Pumice clasts are subangular (Fig.6), up to 13cm in size, and fibrously vesiculated. Mud clasts up to 20cm are contained in the basal part (Fig.3). The Hjp Tephra Bed is overlain by turbidite sand bed with sole marks (Fig.5).

The Hjp Tephra Bed in the Manzo River route is situated in south of Ohshimizu, at 400m eastward from the Hokuriku High Way in southwestern Kashiwazaki City. Its location corresponds to 3.5km SSW from the Cape Hijirigahana locality. At the Manzo River route, the Hjp Tephra Bed is more than 4m thick (Fig.2), though the base is not observed. The middle 230cm grades from coarse sand containing abundant subangular pumice clasts (Fig.7), up to 5cm, to very fine sand size as a whole. Parallel and cross laminations are developed. The upper part is white ash of about 150cm thick, graded from very fine sand to silt size.

Correlation of the Hjp to the Znp Tephra Bed

The Hjp and Znp Tephra Beds are intercalated in the early Pliocene Formations, namely the Hijirigahana and Hamatsuda Formations respectively. They are thick tephra beds containing abundant subangular fibrously vesiculated pumice clasts in common.

Petrographically, the glass shards of Znp tephra is composed of two types (Fig.10). The one is characteristic bubble-junction type composing the matrix. The other is fibrously vesiculated shards composing pumice clasts and their fragments. The shards at Manzo River is also composed of these two types of shards (Fig.8), and those of the Cape Hijirigahana are plenty of fibrously vesiculated shards. Mafic minerals in the Hjp Tephra is scanty, and biotite is predominant, as similar to the Znp Tephra. Thus, petrography of the components

Fig.2. Field occurrence of the Hijirigahana (Hjp) Tephra Bed at the Manzo River route, south of Ohshimizu, western Kasiwazaki City in the Yoneyama area.

Fig.3. Field occurrence of the Hjp Tephra Bed at the Cape Hijirigahana, western Kasiwazaki City in the Yoneyama area. Mud-clasts are incorporated in the basal part.

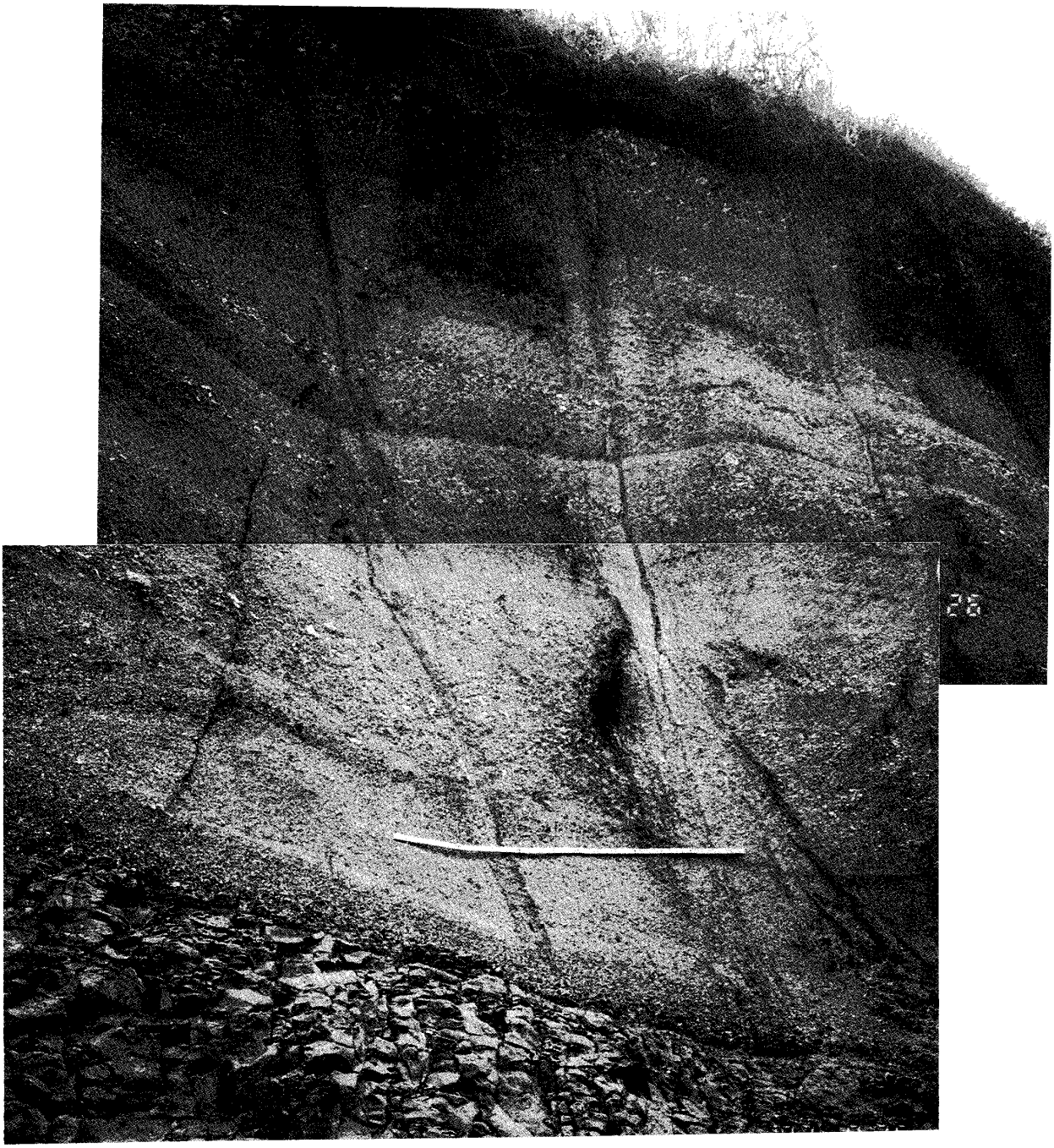

Fig.4. Field occurrence of the Znp Tephra Bed at Yamada, Teradomari Town in the Nishiyama Oil Field as a pumiceous submarine gravity flow deposit. The photo represents the lower half of the Znp Tephra Bed and corresponds to the PartA and the lower half of the PartB in Kurokawa and Kanke (2003). The scale is 1m long. The whole scenery is shown in Fig.9.

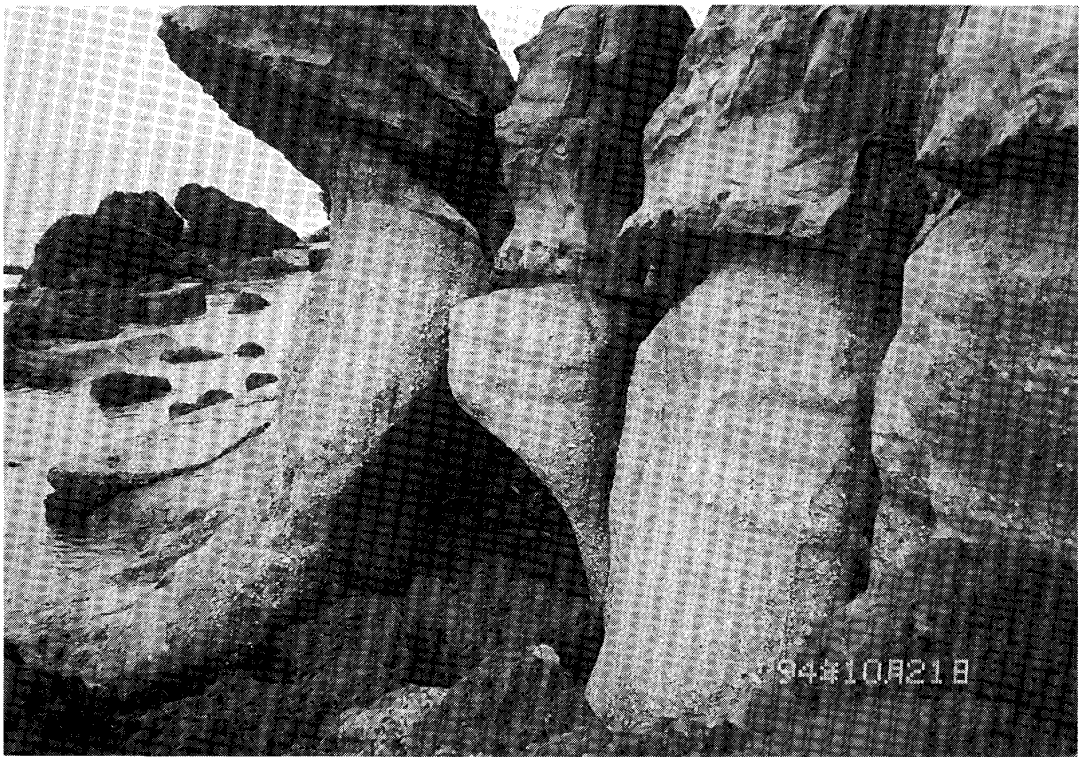

Fig.5. Field occurrence of the Hjp Tephra Bed at the Cape Hijirigahana, western Kasiwazaki City in the Yoneyama area. It is overlain by the turbidite sand bed.

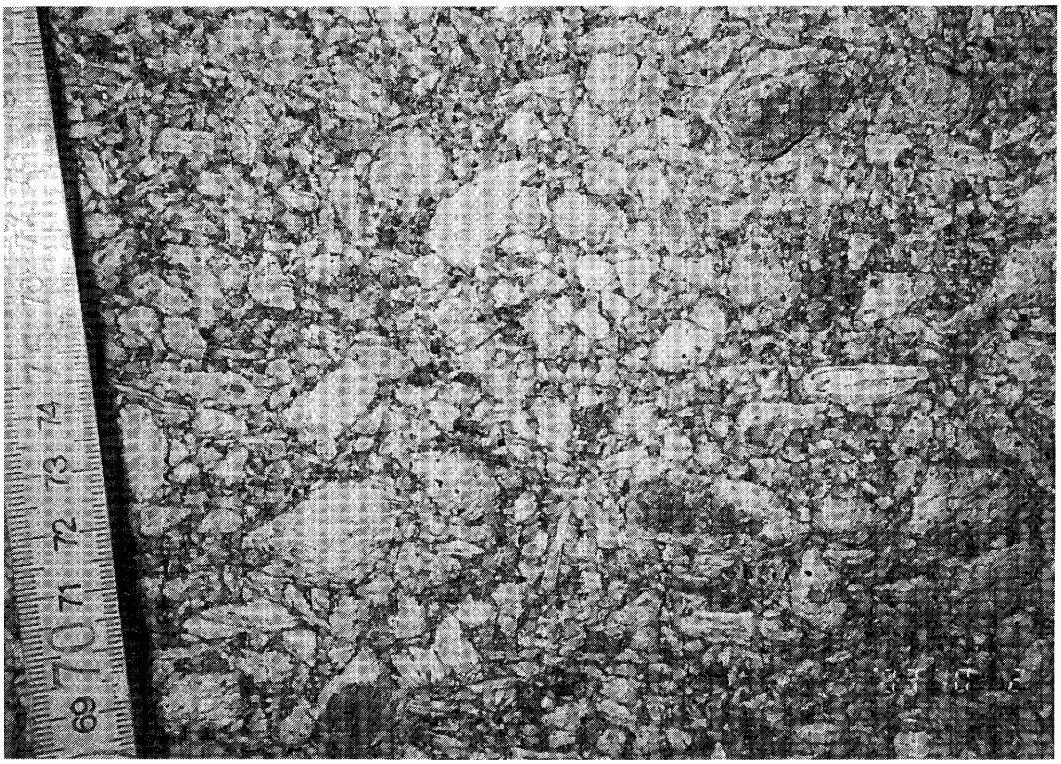

Fig.6. Aggregated pumice clasts in the Hjp Tephra Bed at the Cape Hijirigahana (Fig.5). Pumice clasts are subangular and show jig-saw fits.

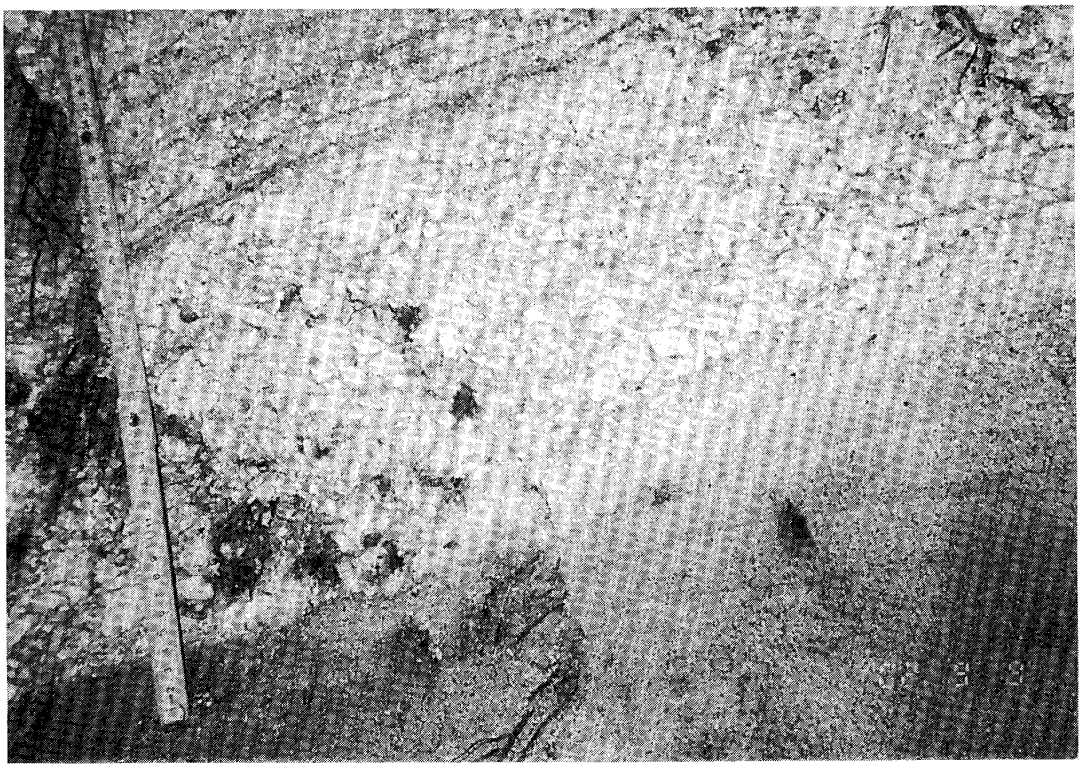

Fig.7. Aggregated pumice clasts in the Hjp Tephra Bed at the Manzo River route. Pumice clasts are subangular. The pumice aggregated part (about 20cm thick) cuts the laminae of the underlying part.

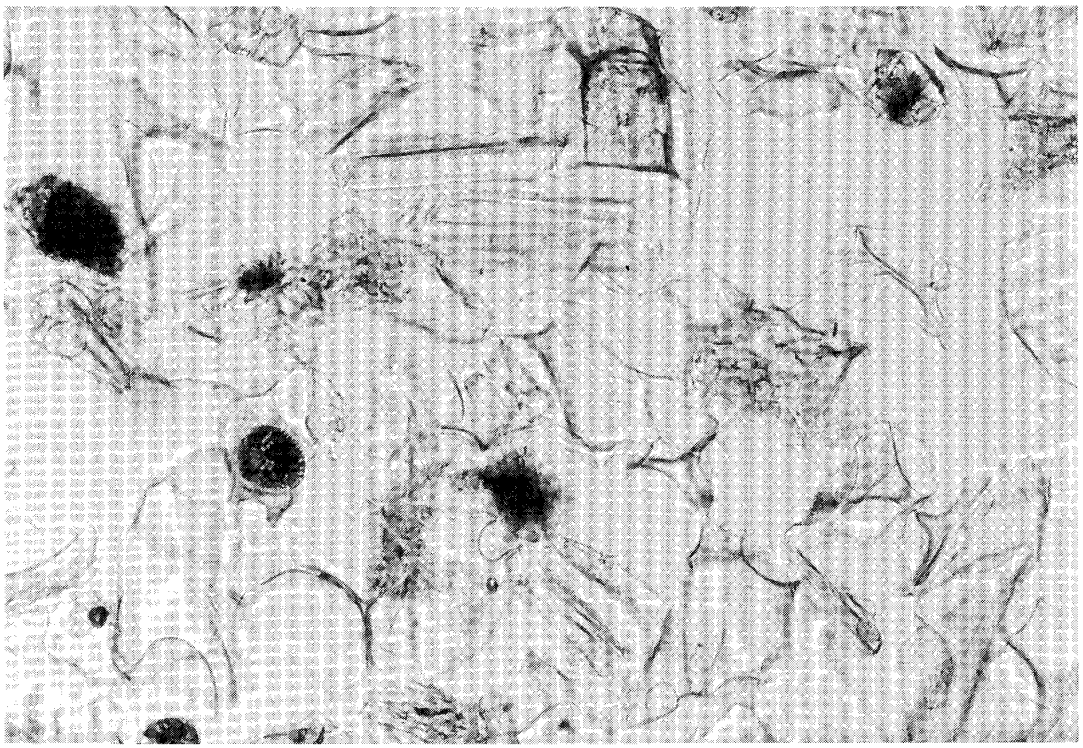

Fig.8. Components of the Hjp Tephra at the Manzo River, Kasiwazaki City in 3ϕ-4ϕ fraction. Bubble-junction type glass shards dominate accompaning fibrously vesiculated shards. (The width of the photo is 1.2mm. The photo was taken at the position under the upper nicol rotated 30° from the crossed position as same in the following photos).

Fig.9. The whole scenery of the Znp Tephra Bed at Yamada, Teradomari Town in the Nishiyama Oil Field. The Znp Tephra Bed continues above the cliff (Fig.4) and more than 6m in thickness.

Fig.10. Components of the Znp Tephra at Yamada Teradomari Town in 3ϕ-4ϕ fraction. The sample was taken from the upper part of the Part B in Kurokawa and Kanke (2003). Bubble-junction type glass shards dominate accompaning fibrously vesiculated shards.

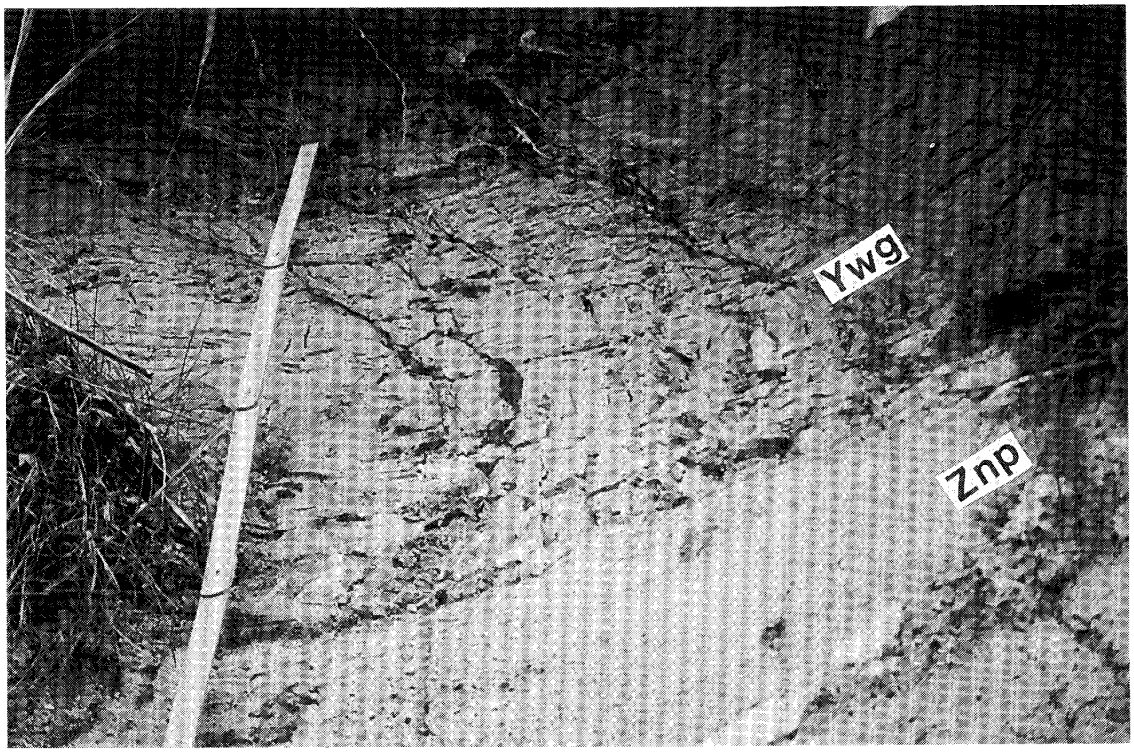

Fig.11. Field occurrence of the top of the Znp Tephra Bed (PartC) and the directly overlying fine-graind Ywg Tephra Beds (Kurokawa et al., 1987) at Yamada, Teradomari Town. The Znp and the Ywg comprise a single composite tephra sequence in the Nishiyama Oil Field.

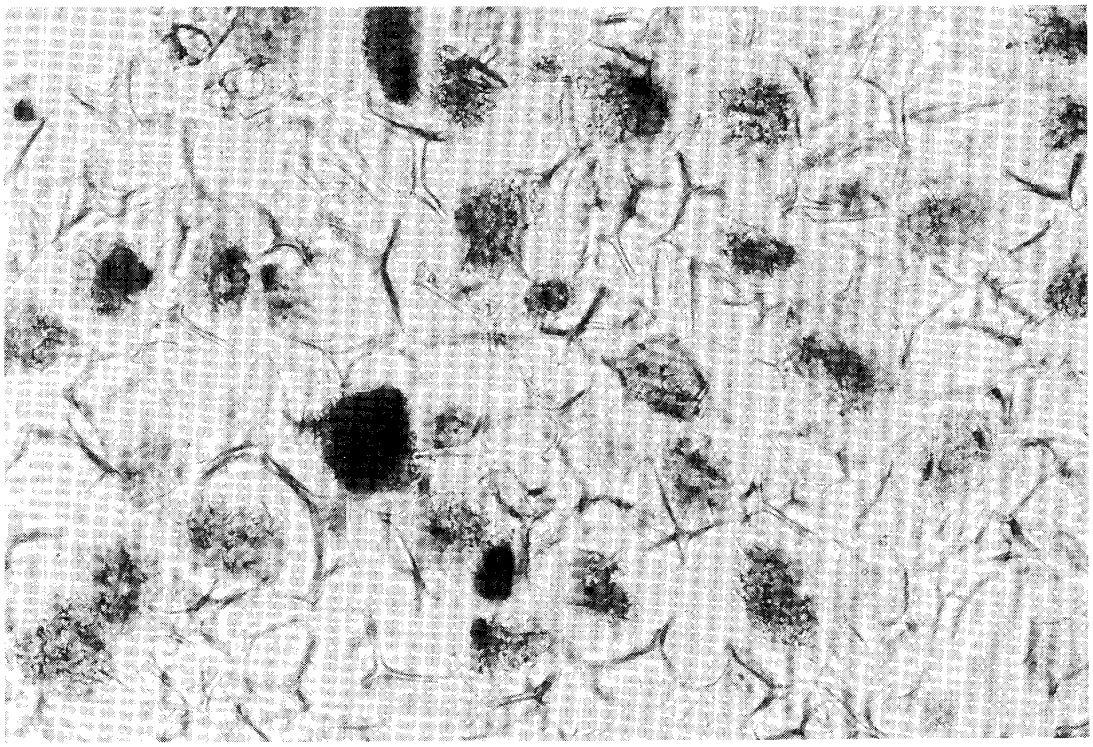

Fig.12. Components of the directly overlying Ywg Tephra (Fig.11) at Yamada in 3ϕ-4ϕ fraction. In the Ywg Tephra, characteristic bubble-junction type glass shards are predominant.

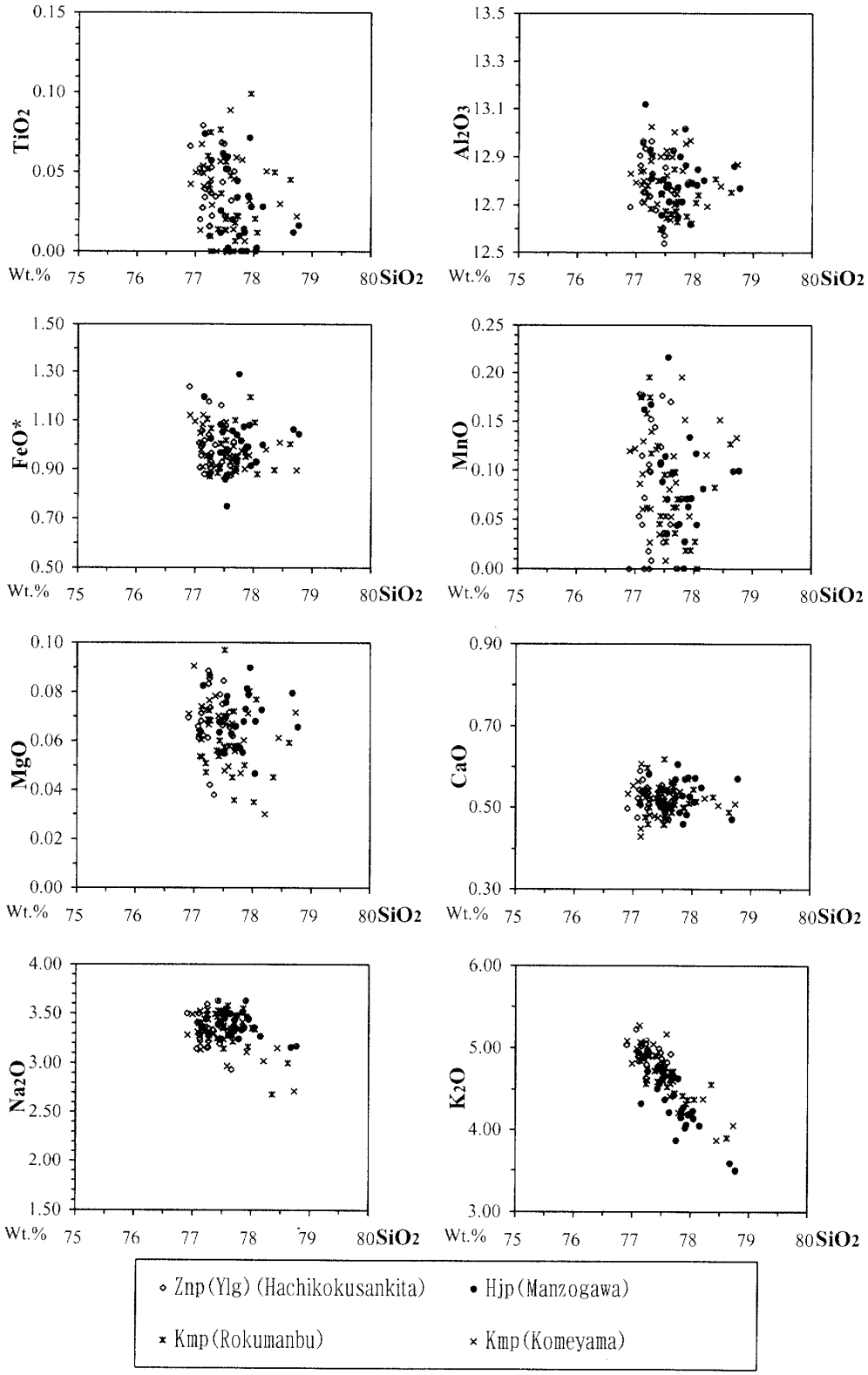

Fig.13. SiO_2-oxides diagrams of the chemical composition of the glass shards of the Znp (Ylg) Tephra at Hachikokusankita (1km north of the Yakushi Pass) in Nagaoka City and the Hjp Tephra at the Manzo River in Kashiwazaki City. The data of the Komeyama Tephra Bed (Kmp) at Rokumanbu and Komeyama in Yoshikawa Town, southwestern Yoneyama area are also shown (total oxide weights were converted to 100%).

Table1. Chemical composition of the glass shards of the Znp, Ywg, Ylg, Kwg, Hjp, Kmp, PM and Ohta Tephras in weight percent. Sampling localities are same as in Fig.13 and Fig.14. The An85 Tephra, sampled at Mikutazawa, Kimitsu City in Boso Peninsula, is also suggested to be correlative to the Znp by Higuchi and Kurokawa (2003). Total oxide weights were converted to 100%. FeO* denotes the total Fe as FeO. The average (Ave.) and standard deviation (S.D.) are shown in the upper table, and the range is shown in the lower table. (n) shows the number of analysed grains and (r) shows the analytical round.

Tephra bed	Sample Locality	SiO_2		TiO_2		Al_2O_3		FeO*		MnO		MgO		CaO		Na_2O		K_2O		n	r
		Ave.	S.D.	Ave.	S.D.	Ave.	S.D.	Ave.	S.D.	Ave.	S.D.	Ave.	S.D.	Ave.	S.D.	Ave.	S.D.	Ave.	S.D.		
Ylg	Hachikokusankita	77.10	0.27	0.02	0.03	13.08	0.13	0.95	0.11	0.06	0.03	0.03	0.01	0.55	0.04	3.01	0.20	5.19	0.18	21	1
Ylg	Hachikokusankita	77.28	0.20	0.04	0.02	12.78	0.13	0.99	0.10	0.09	0.06	0.07	0.01	0.52	0.03	3.30	0.14	4.92	0.13	25	2
Ywg	Yamada	76.83	0.46	0.03	0.03	13.08	0.21	0.96	0.12	0.07	0.04	0.03	0.01	0.58	0.11	3.15	0.25	5.26	0.33	24	1
Znp	Yamada	77.07	0.41	0.03	0.03	13.18	0.22	0.98	0.09	0.08	0.04	0.03	0.01	0.55	0.05	3.07	0.26	5.00	0.16	21	1
Kwg	Kamiarasawa	77.06	0.34	0.02	0.02	13.10	0.14	0.93	0.09	0.07	0.05	0.03	0.01	0.54	0.05	3.21	0.18	5.04	0.34	21	1
Hjp	Manzogawa	77.78	0.38	0.03	0.02	12.80	0.11	1.00	0.11	0.09	0.05	0.07	0.01	0.53	0.04	3.40	0.12	4.30	0.34	25	2
Kmp	Rokumanbu	77.64	0.36	0.03	0.03	12.73	0.09	0.98	0.09	0.08	0.05	0.06	0.01	0.52	0.04	3.34	0.20	4.62	0.25	24	2
Kmp	Komeyama	77.53	0.45	0.04	0.02	12.83	0.10	0.98	0.08	0.10	0.05	0.06	0.01	0.52	0.04	3.27	0.18	4.68	0.36	25	2
PM	Ao	76.99	0.35	0.04	0.03	13.08	0.12	0.96	0.09	0.05	0.05	0.03	0.01	0.55	0.04	2.86	0.24	5.44	0.23	23	1
Ohta	Ohtani	77.20	0.26	0.03	0.02	13.04	0.08	0.95	0.10	0.06	0.05	0.03	0.01	0.55	0.04	3.03	0.35	5.12	0.30	25	1
An85	Mikutazawa	77.39	0.20	0.02	0.02	12.73	0.09	1.01	0.08	0.09	0.05	0.06	0.01	0.52	0.03	3.42	0.11	4.76	0.14	25	2

Tephra	Locality	SiO_2	TiO_2	Al_2O_3	FeO*	MnO	MgO	CaO	Na_2O	K_2O	r
Ylg	Hachikokusankita	76.6-77.7	0.00-0.10	12.8-13.3	0.76-1.20	0.01-0.13	0.01-0.05	0.48-0.61	2.65-3.48	4.92-5.58	1
Ylg	Hachikokusankita	76.9-77.7	0.00-0.08	12.5-13.0	0.86-1.24	0.00-0.18	0.04-0.09	0.47-0.59	2.94-3.60	4.64-5.23	2
Ywg	Yamada	76.1-78.6	0.00-0.09	12.9-13.3	0.69-1.20	0.01-0.13	0.01-0.07	0.50-0.73	2.05-3.36	4.38-5.70	1
Znp	Yamada	76.1-77.8	0.00-0.08	12.9-13.3	0.70-1.14	0.02-0.14	0.01-0.05	0.49-0.65	2.69-3.52	4.67-5.31	1
Kwg	Kamiarasawa	76.2-77.7	0.00-0.09	12.8-13.4	0.76-1.09	0.00-0.17	0.00-0.05	0.46-0.65	2.96-3.58	4.38-5.76	1
Hjp	Manzogawa	77.2-78.8	0.00-0.07	12.6-13.1	0.75-1.29	0.00-0.22	0.05-0.09	0.46-0.61	3.15-3.63	3.87-4.77	2
Kmp	Rokumanbu	77.2-78.6	0.00-0.10	12.6-12.9	0.87-1.19	0.00-0.20	0.03-0.10	0.46-0.62	2.68-3.58	3.91-4.93	2
Kmp	Komeyama	76.9-78.7	0.00-0.09	12.6-13.0	0.88-1.12	0.01-0.20	0.03-0.09	0.43-0.61	2.72-3.53	3.88-5.27	2
PM	Ao	76.4-78.0	0.00-0.10	12.9-13.4	0.78-1.12	0.00-0.18	0.00-0.06	0.49-0.67	2.31-3.37	4.98-5.82	1
Ohta	Ohtani	76.6-77.9	0.00-0.07	12.9-13.2	0.75-1.13	0.00-0.19	0.01-0.05	0.48-0.63	1.86-3.49	4.74-5.91	1
An85	Mikutazawa	77.0-78.8	0.00-0.08	12.6-13.0	0.83-1.12	0.00-0.17	0.05-0.09	0.46-0.60	3.19-3.61	4.50-5.08	2

of the Hjp and the Znp is almost coincident.

For further examination for correlation, the EPMA analyses of the glass shards were made by JXA8600SX microanalyser of Niigata University at 15keV with beam diameter of 20 μm. Analyses were made one of the author (Higuchi,Y.) and calibrated by oxide ZAF method.

The results are shown in Table.1 and Fig.13. In Table.1 and Fig.14, data of so far correlated or related tephras are also shown. The chemical composition of the glass shards of the Znp and Hjp Tephras are well coincident in each oxide content. Especially they are characterized by the low CaO contents of 0.52-0.58% in average. Thus, on the lithology, petrography and chemical composition of glass shards, the Hjp Tephra Bed in the Yoneyama area can be safely correlated to the Znp Tephra Bed in the Nishiyama Oil Field.

As for the western or southern extension of the distribution of the Znp Tephra Bed from the Yoneyama area in the Niigata region was not revealed so far. In the Yoshikawa Town, about 10km south of the Manzo River locality of the Hjp Tephra Bed, the Komeyama Tephra Bed (Kmp) is distributed. The Komeyama Tephra Bed is about 15m thick (Yoshikawa Town,

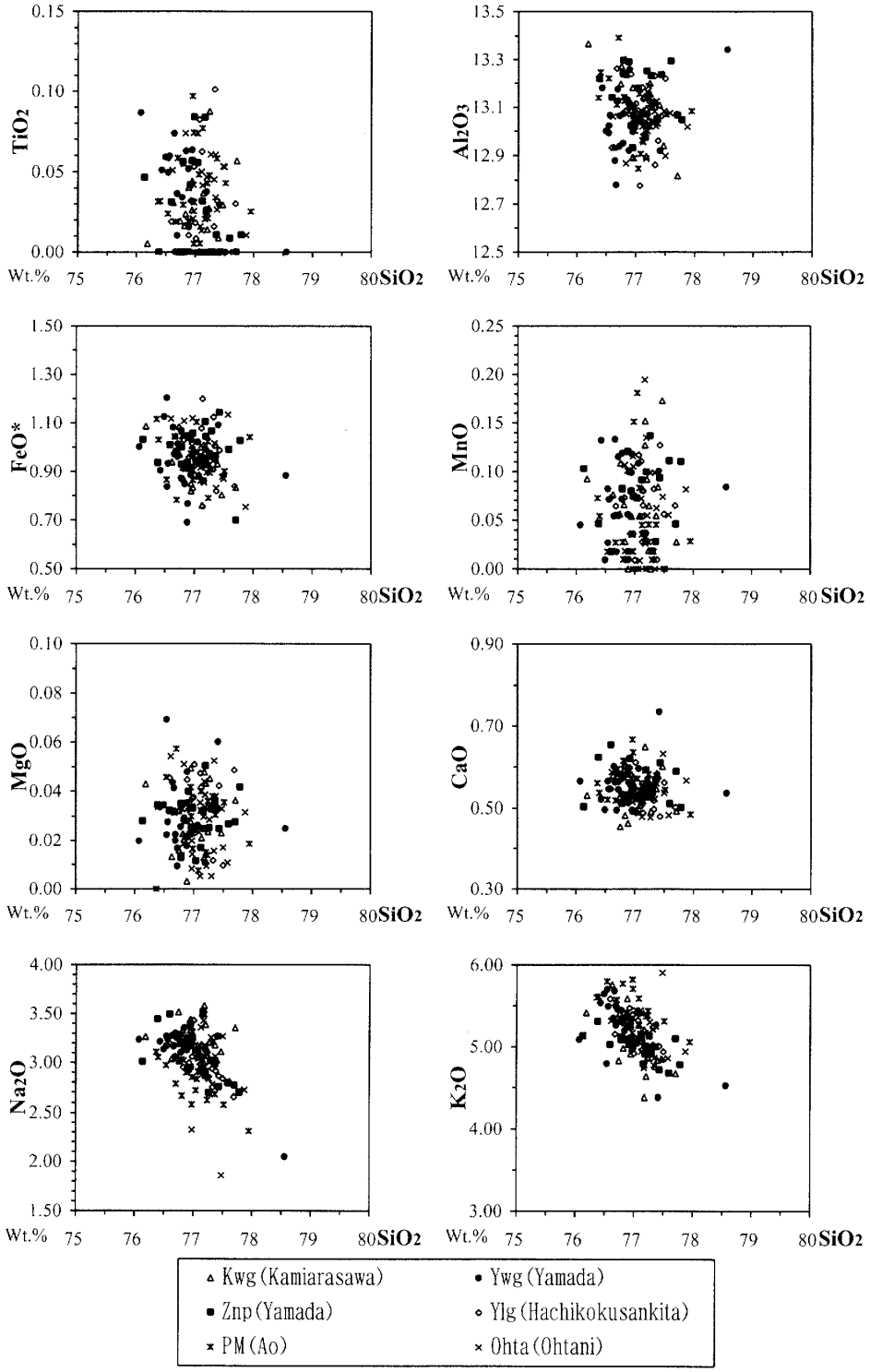

Fig.14. SiO_2-oxides diagrams of the chemical composition of the glass shards of the Znp Tephra and its correlatives. Sampling localities are the Znp and Ywg at Yamada, Teradomari Town in the Nishiyama Oil Field, the Ylg at Hachikokusankita in western Nagaoka City in the Chuo Oil Field, the Kwg at Kamiarasawa, northern Shibata City in the Kitakanbara area in the Niigata region. The PM Tephra in the Himi Group was sampled at Ao, Himi City in Toyama Prefecture and the Ohta (Otani) Tephra in the Tokai Group at Otani, Tokoname City in Aichi Prefecture (total oxide weights were converted to 100%).

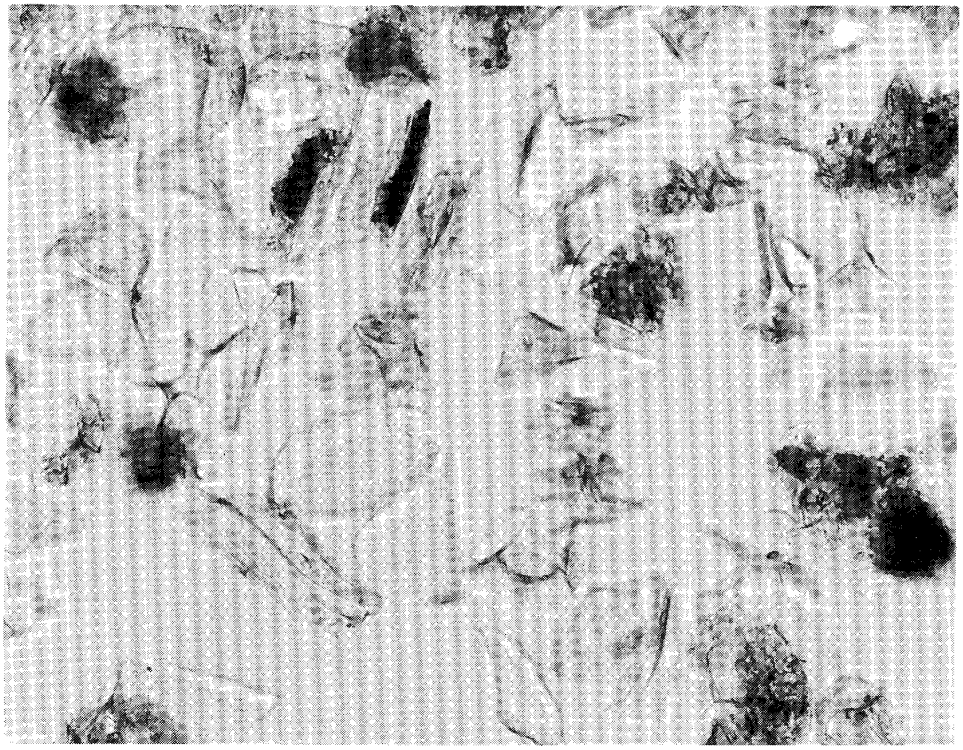

Fig.15. Components of the Komeyama Tephra (Kmp) at Komeyama in Yoshikawa Town, southwestern Yoneyama area in 3ϕ-4ϕ fraction. Bubble-junction type glass shards dominate accompaning fibrously vesiculated glass shards.

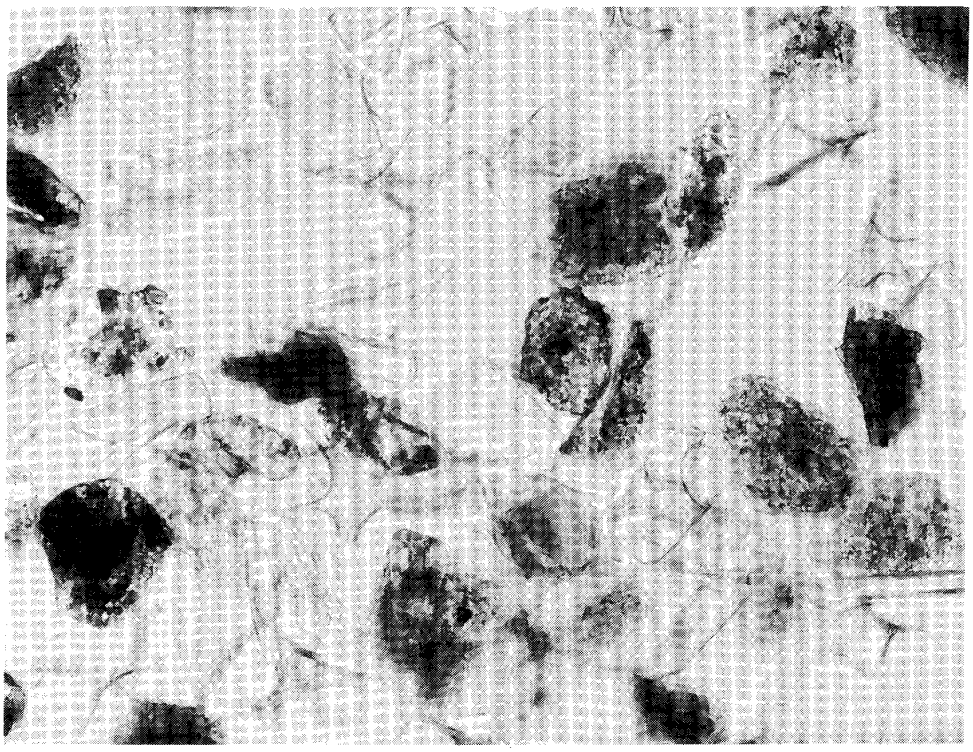

Fig.16. Components of the Komeyama Tephra (Kmp) at Rokumanbu in Yoshikawa Town, southwestern Yoneyama area in 3ϕ-4ϕ fraction. Bubble-junction type glass shards dominate accompaning fibrously vesiculated glass shards.

1996; Takeuchi et al., 1996). The Kmp Tephra contains bubble-junction type glass shards (Figs.15,16) and a small amount of biotite. Chemical composition of the glass shards are similar to those of the Hjp and Znp Tephras such as CaO content (0.52%) as shown in Fig.13 and Table1. Thus, the Kmp Tephra Bed has the possibility to be southern extension of the Hjp Tephra Bed.

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*in Japanese with English abstract

**in Japanese