

(Draft) EMS's views against JAPC's claim concerning the fault evaluations of Tsuruga PS site, EMS on shatter zones in the site of Tsuruga Power Station		JAPC's opinion	Reference No.
Main texts	Issues		
<p><EMS's views on the claim 3> (1) The operator's claim that D-1 fault is not the active fault to be taken into consideration. ➤ (Skipped)</p>	—	<p>(Original thoughts)</p> <ul style="list-style-type: none"> - Though the detected amount is small, hornblendes are broadly distributed in the same horizon while Kojaku granites or dolerites which compose the rock mass do not include hornblende. Therefore, it is considered to the amphibolite which originate in the tephra. - Although somewhat re-deposition of layer is indicated by the repeated change of amounts of amphibolite with increasing and decreasing along up and down direction, the lower occurrence limit is present on or above the bottom of layer⑤, therefore it is judged that the bottom of layer⑤ and the lower occurrence limit almost indicate the period in which the tephra was fallen. - From the points above, there is not problem in the identification method. 	—
<p>(2) Identification of the tephra by analyzing minerals ➤ As for analyzing the minerals contained in tephra, it is general to compare with main components of the several types of tephra to be concerned. However, the operator determined it is the same tephra <u>only by comparing with the tephra, dating back to approx. 120 – 130 thousand years ago (the operator calls it 'Mihama tephra')</u> and the <u>identification method is considered to be insufficient.</u></p> <p>(3) Specification of the deposit which contains the tephra ➤ Since the content percentage of the mineral (amphibolite) detected by the lower part of layer⑤ is <u>low frequency which is less than one per 3,000 counts, and small amount of the mineral (amphibolite) are included in layer③</u> that is lower level, the operator's claim that the lower part of layer⑤ is deposited with the tephra, dating back to 120 – 130 thousand years ago is not reliable assumption. ➤ In order to specify the layer in which the tephra is deposited, it is preferable to recognize volcanic ashes by checking them with eyes. If it is not available with the eye inspection, there is also a way to specify the age, applying the method to count the minerals contained in the tephra in the layer. In that case, <u>it is difficult to specify the layer in which the tephra is deposited unless large amount of minerals are contained in the layer while there is significant difference between the upper and the lower layers.</u></p>	<ul style="list-style-type: none"> - The result of main components analysis has only been compared with Mihama tephra. - The contents of the minerals is low frequency, and it cannot be specified as the layer in which the tephra is deposited unless there is a significant difference between the upper and the lower layers. - Amphibolite is also included in layer③. 	<p>(Outline of today's explanation (new data))</p> <ol style="list-style-type: none"> 1. Stratigraphy of D-1 trench => Layer⑤ was deposited in the warm period, while deposit period of layer③ was colder than layer⑤. 2. Regarding hornblendes included in the lower part of layer⑤ and layer③ => Significant difference has been recognized between the hornblende in lower part of layer ⑤ and the one in layer③ in a result of main composition analysis, although mineral products are quite little because they are gravel. => It was identified that the hornblendes produced in the specific layer of the lower part of layer③ was the amphibolite which originated in the tephra. => It was identified that the lower part of layer⑤ was not the re-deposition of layer③ . 3. Hornblendes detected in the lower part of layer⑤ => There is a high possibility that the hornblendes in the lower part of the layer⑤ is Mihama tephra. => Daisen-Hiruzenpara and BT37 are distributed lower than Sanbe-Kisuki (110-115Ka), which are the tephra, deposited in the marine isotope stage 5e. => Therefore, it is considered that the lower part of layer⑤ should be the deposit of the marine isotope stage 5e. => Layer③ is deposit in marine oxygen isotope stage 6 or before, with consideration that layer③ is lower and colder than layer⑤. <p>In addition,</p> <ul style="list-style-type: none"> - additional analyses are implemented by increasing the survey lines in the D-1 trench in order to be progress of the reliability. - the main components are to be identified as for Daisen-Hiruzenbara. - BT 37 is 127.6ka according to the existing literature though it cannot to be confirmed as it is difficult to obtain the sample. <p>(Points to be clarified by EMS)</p> <ul style="list-style-type: none"> - Considering the above, is there still the reason that the lower part of layer⑤ and layer③ are not respectively MIS5e and MIS6? - The EMS confirmed that the geologic layer where the deformation of the K fault ran up did not reach to the silt layer of layer③. 	61-78

1. Regarding geologic stratigraphic sequence of D-1 trench

Investigation for deposits of trench inside

- Dividing stratigraphy into layers as No. ①~⑨ based on observation of the slope surface.
 - Layer ⑤ accumulated with eroding layer ③ deeply.
 - Layer ③ consists of lager particle accumulation comparing with layer ⑤.
- Pollen analysis
 - Only layer ② and lower part of layer ⑤ include pollen at warm period. It has not been detected in layer ③.
- Survey of tephra (Continuous 10cm sampling on slope surface)
 - Layer ⑦ includes DKP, upper part of layer ⑤ includes K-Tz.
 - Lower part of layer ⑤ and layer ③ include hornblende, although they are quite little.

Sketch, Stratigraphic table

Pollen analysis

Survey of tephra
Photo. of hornblende

⇒ Layer ⑤ accumulated at warm period, and layer ③ accumulated at colder period than layer ⑤.

2. Regarding hornblende in lower part of layer ⑤ and layer ③

Study for the origin of hornblendes detected in lower part of layer ⑤ and layer ③

- Mineral composition ratio in the basement rock of Tsuruga site.
 - It is confirmed that the basement rock doesn't include hornblende.
- Analysis of reflective index and main component in two layers
 - The hornblende of layer ③ is confirmed to differ from the one of lower part of layer ⑤.
 - Lower part of layer ⑤ doesn't include the same hornblende to layer ③.
 - Values of properties are concentrated in the same for every hornblende of lower part of layer ⑤

Mode analysis

Main components analysis

⇒ Significant difference has been recognized between the hornblende in lower part of layer ⑤ and the one in layer ③ in a result of main composition analysis, although mineral products are quite little because they are gravel.
 ⇒ The hornblende produced from particular lower part of layer ⑤ have been found amphibolite which have the origin of tephra.
 ⇒ The lower part of layer ⑤ have been found that it didn't re-accumulate from layer ③.

3. The origin of hornblende detected in lower part of layer ⑤

Study for the origin of hornblendes detected in lower part of layer ⑤ and layer ③

- Mineral composition ratio in the basement rock of Tsuruga site.
 - It is confirmed that the basement rock doesn't include hornblende.
- Analysis of reflective index and main component in two layers
 - The hornblende of layer ③ is confirmed to differ from the one of lower part of layer ⑤.
 - Lower part of layer ⑤ doesn't include the same hornblende to layer ③.
 - Values of properties are concentrated in the same for every hornblende of lower part of layer ⑤

Papers

Main components analysis

⇒ There is a high possibility that the hornblende in lower part of Layer ⑤ is Mihama-Tephra
 ⇒ Both Daisen-Hiruzenpara and BT37 are distributing lower than Sanbekisuki(110-115Ka), and these are tephras accumulated at Marine Oxygen Isotope Stage 5e.
 ⇒ Therefore, lower part of layer ⑤ has to be an accumulation at Marine Oxygen Isotope Stage 5e.
 ⇒ Layer ③ is accumulation at Marine Oxygen Isotope Stage 6 or before, with consideration that layer ③ is lower and colder than layer ⑤.

【Points to be checked with EMS】

Is there a reason that Layer ⑤ and Layer ③ are not MIS5e and MIS6 respectively, regardless of above results?

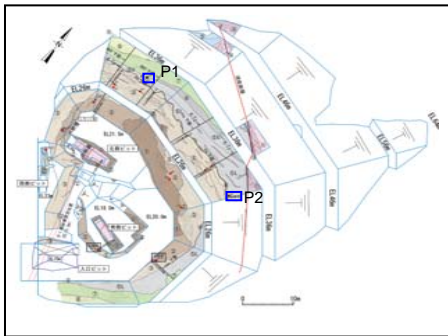
- In order to be progress of reliability, additional surveys are conducted with increasing of analysis line at D-1 trench.
- Main components of Daisen-Hiruzenpara will be investigated.
- BT37 is 127.6ka according to paper, although we couldn't confirm with sampling.

Geologic stratigraphic sequence of D-1 trench

Layer name		Color tone	Facies	Chronometric indicator	
				Tephra	Pollen
Layer ⑨		Brown -darkish yellow brown	Sandy silt with gravel. Contact with lower layer in the horizontal unconformity surface.	-	-
Layer ⑧		Brown -yellow orange	Mainly composed of gravel. Matrix is silty sand. Stratification structure is partly seen. Contact with lower layer in the horizontal unconformity surface.	/	-
Layer ⑦		Brown -brownish gray	Sandy silt with gravel - Silty sand with gravel. Contact with lower layer in the horizontal unconformity surface.	Including DKP	/
Layer ⑥		Gray-dark gray	Humic sandy silt-silty sand Contains lots of wood chips. Contact with lower layer in the horizontal unconformity surface.	-	/
Layer ⑤	U (Upper part)	Ash gray -slight yellow orange	Mainly composed of silty gravel.	Including K-Tz	-
	L (Lower part)	Ash gray -slight yellow orange	Mainly composed of silty gravel. Silty gravel layer and silt layer present discontinuous alteration. Erode layer③ and contact with it in the unconformity surface	Including hornblende	Including pollen at warm period
Layer ③	Layer ④*	Brown	Mainly composed of oxidized gravel. Distributed just beneath unconformity surface with undulation and denudation.	Including hornblende	-
	※ Oxidized zone of upper end of layer ③ located just beneath unconformity surface.	Slight yellow orange -orange	Mainly composed of gravel. Silt layer and sand layer occur in a lenticular and laminae form. Contact with unconformity surface denuding lower layer.		
Layer ②		Darkish orange-ash gray	Sandy silt-silty sand that is massive structure and contains lots of decayed gravel	-	Including pollen at relatively warm period
Layer ①		Darkish red brown -bright brownish yellow	Mainly composed of gravel. Insufficient sorting and very tight	-	-
⑩ Kojaku granite		Ash gray- Brown	Rock mass that constitutes basement. Consist of biotite granite, granite porphyry and aplite.	-	/

- layer ⑤ was deposited with widely scraping layer ③.
 - layer ③ consists of coarse-grained deposits and contains no organics even in relatively/rather fine grain. (environment is estimated to be devoid of vegetation around. Pollens are not detected.), while layer ⑤ consists of fine grained sediments in addition to coarse-grained deposits containing organics. (environment is estimated to be vegetation around. Pollens of warm interval are detected.)
 - layer ③ takes on brown in whole compared to layer ⑤, while layer ⑤ takes on reductive color in whole compared to layer ③.
- As above, layer③ and layer⑤ have different depositional environment even in case that both are fan deposits of the same slope.

The results of pollen analysis in D-1 trench (at P1, P2)



Sampling location

		P1	P2
木本花粉	Arboreal Pollen		
モミ属	<i>Abies</i>	-	5
ツガ属	<i>Tsuga</i>	78	17
トウヒ属	<i>Picea</i>	1	3
マツ属複雑管束亜属	<i>Diploxylon</i>	-	15
マツ属 不明	<i>Pinus</i>	107	65
スギ属	<i>Cryptomeria</i>	-	55
イチイ科—イヌガヤ科—ヒノキ科	T.-C.	-	4
ハンノキ属	<i>Alnus</i>	12	6
ブナ属	<i>Fagus</i>	2	3
コナラ属コナラ亜属	<i>Lepidobalanus</i>	-	5
コナラ属アカガシ亜属	<i>Cyclobalanopsis</i>	-	30
ニレ属—ケヤキ属	<i>Ulmus-Zelkova</i>	-	1
モチノキ属	<i>Ilex</i>	-	4
ハインキ属	<i>Symplocos</i>	-	3
草本花粉	Nonarboreal Pollen		
フウロソウ属	<i>Geranium</i>	1	-
ヨモギ属	<i>Artemisia</i>	1	-
キク亜科	Carduoideae	5	-
不明花粉	Unknown Pollen		
不明花粉	Unknown pollen	1	4
シダ植物孢子	Pteridophyta Spores		
他のシダ植物孢子	other Pteridophyta spores	160	221
合計	TOTAL		
木本花粉	Arboreal Pollen	200	216
草本花粉	Nonarboreal Pollen	7	0
不明花粉	Unknown Pollen	1	4
シダ植物孢子	Pteridophyta Spores	160	221
総花粉・孢子(不明を除く)	Total Number of Pollen & Spores	367	437
分析後残渣の観察			
有機物残渣量: VA: Very Abundant (非常に多い), A: Abundant (多い), C: Common (普通), F: Few (少ない), Tr: Trace (痕跡程度 (微量))		Tr	A
花粉・孢子化石の産出傾向: VA: Very Abundant (非常に多い), A: Abundant (多い), C: Common (普通), R: Rare (稀れ), VR: Very Rare (極く稀れ), N: Non (無化石)		R	C
花粉・孢子化石の保存状態: VG: Very Good (非常に良い), G: Good (良い), M: Moderate (普通), P: Poor (悪い), VP: Very Poor (非常に悪い)		VP	P

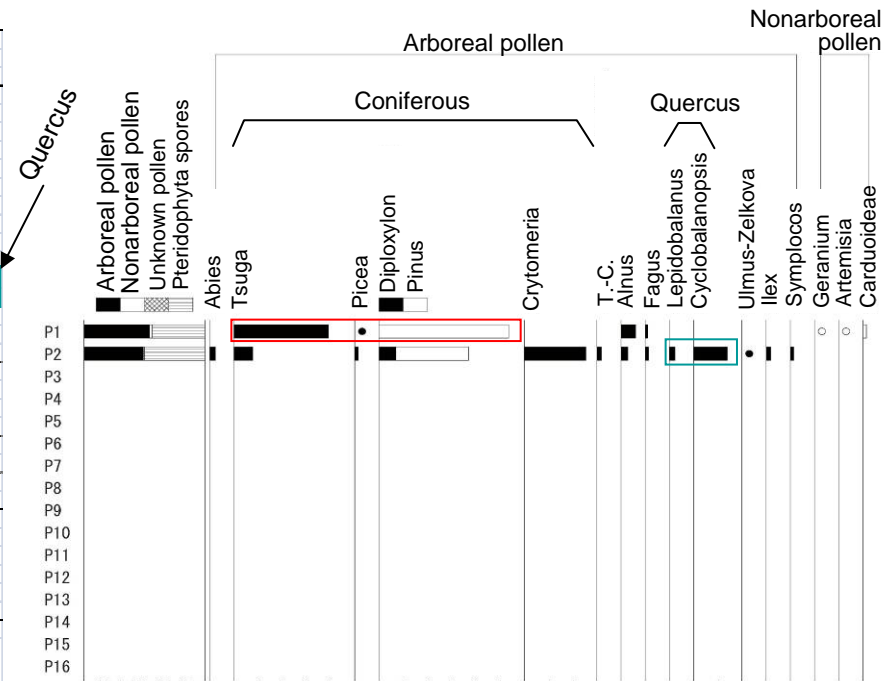


Fig. Fossil pollens list

Appearance rates are represented by percentage with total arboreal as cardinal number in arboreal, and in nonarboreal, with total taken unknown off. And ● Osymbols indicate less than 1%.

P1: The top of layer⑤

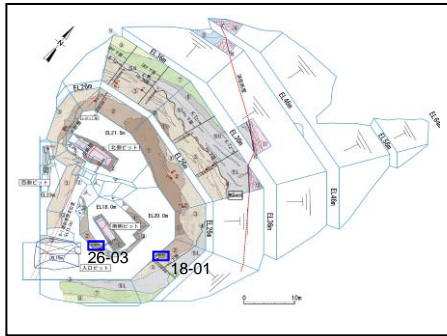
Paleoclimate is not estimated, because almost all pollen produced is coniferous and pteridophyta spores, and these are not reflected vegetation at that time.

P2: The bottom of layer⑤

As produced pollens are not only coniferous like pinus, cryptomeria and tsuga, but also broadleaved tree like quercus, it is estimated that it was warm period comparatively.

Although lagerstroemia or hemiptelea is observed in the case of Marine Oxygen Isotope stage 5 generally as nationwide feature, they have not been detected in this sample.

The results of pollen analysis in D-1 trench (at 18-01, 26-03)



Sampling location

		D1	D1	D1	D1
		Po	Po	Po	Po
		18-01	26-01	26-02	26-03
木本花粉	Arboreal Pollen				
モミ属	<i>Abies</i>	10	-	-	4
ツガ属	<i>Tsuga</i>	46	-	-	24
トウヒ属	<i>Picea</i>	7	-	-	10
ヒマラヤスギ属	<i>Cedrus</i>	7	1	-	-
マツ属単維管束亜属	<i>Haploxyylon</i>	12	-	-	1
マツ属複維管束亜属	<i>Diploxyylon</i>	5	-	-	6
マツ属 不明	<i>Pinus</i>	77	-	-	20
スギ属	<i>Cryptomeria</i>	76	-	-	148
イチイ科—イヌガヤ科—ヒノキ科	T.-C.	1	-	-	-
カバノキ属	<i>Betula</i>	1	-	-	2
ハンノキ属	<i>Alnus</i>	4	-	-	3
ブナ属	<i>Fagus</i>	-	-	-	3
コナラ属コナラ亜属	<i>Quercus</i> subgen. <i>Lepidobalanus</i>	12	-	-	11
コナラ属アカガシ亜属	<i>Quercus</i> subgen. <i>Cyclobalanopsis</i>	1	-	-	-
ニレ属—ケヤキ属	<i>Ulmus-Zelkova</i>	1	-	1	1
ツゲ属	<i>Buxus</i>	-	-	-	2
ウルシ属	<i>Rhus</i>	1	-	-	-
カエデ属	<i>Acer</i>	1	-	-	-
草本花粉	Nonarboreal Pollen				
カヤツリグサ科	Cyperaceae	3	-	-	1
カラマツソウ属	<i>Thalictrum</i>	1	-	-	-
キク亜科	Carduoideae	1	-	-	-
不明花粉	Unknown Pollen				
不明花粉	Unknown pollen	1	-	-	1
シダ植物孢子	Pteridophyta Spores				
他のシダ植物孢子	other Pteridophyta spores	38	-	-	20
合計	TOTAL				
木本花粉	Arboreal Pollen	262	1	1	235
草本花粉	Nonarboreal Pollen	5	0	0	1
不明花粉	Unknown Pollen	1	0	0	1
シダ植物孢子	Pteridophyta Spores	38	0	0	20
総花粉・孢子	Total Number of Pollen & Spores	305	1	1	256
分析後残渣の観察					
有機物残渣量: VA: Very Abundant (非常に多い), A: Abundant (多い), C: Common (普通), F: Few (少ない), Tr: Trace (痕跡程度 (微量))		VA	Tr	Tr	VA
有機物形態: am: amorphous 主体, mix: 混在, wo: woody・coaly・herbaceous 主体		wo	wo	wo	wo
花粉・孢子化石の産出傾向: VA: Very Abundant (非常に多い), A: Abundant (多い), C: Common (普通), R: Rare (稀れ), VR: Very Rare (極く稀れ), N: Non (無化石)		A	VR	VR	A
花粉・孢子化石の保存状態: VG: Very Good (非常に良い), G: Good (良い), M: Moderate (普通), P: Poor (悪い), VP: Very Poor (非常に悪い)		M	M	M	M

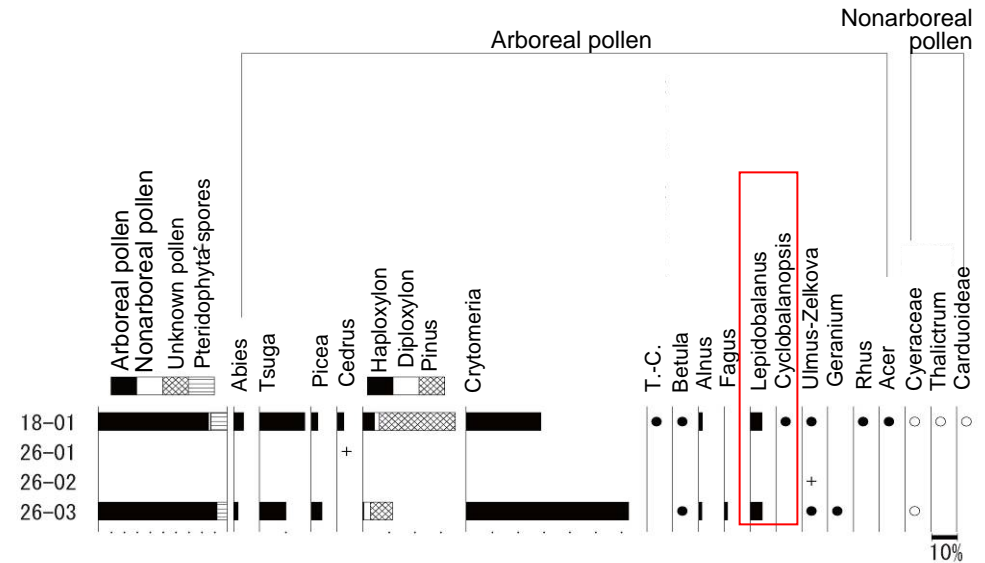


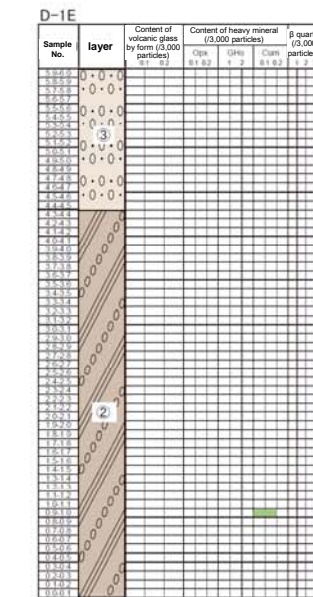
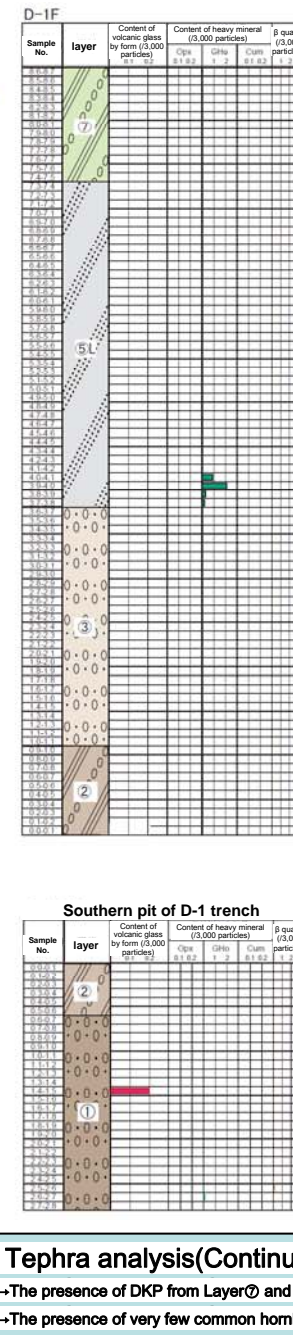
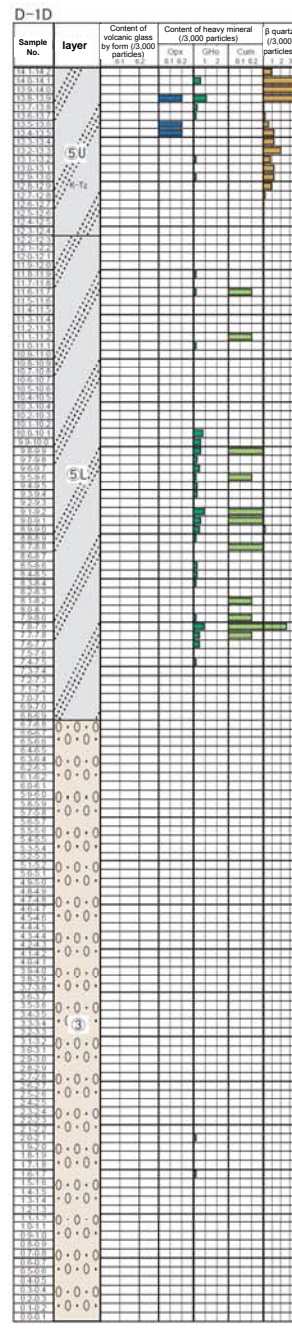
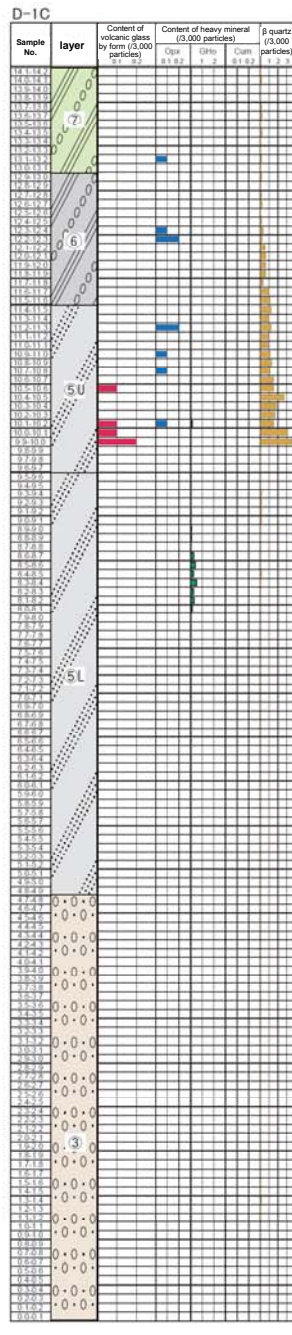
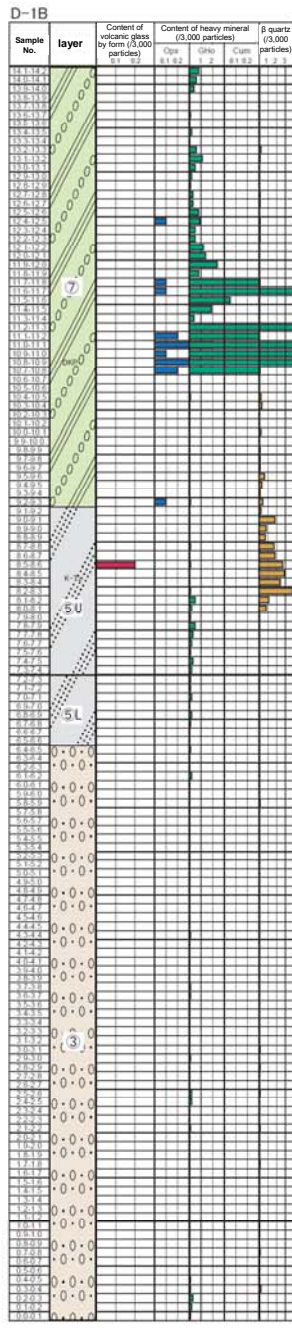
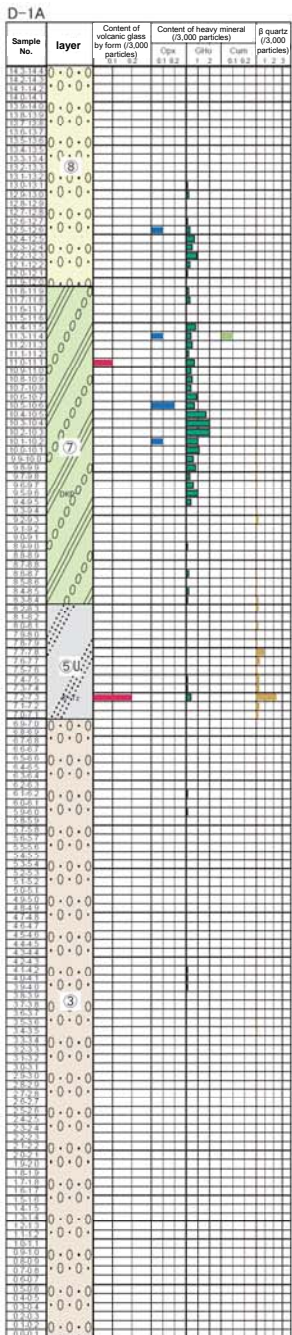
Fig. Fossil pollens list

Appearance rates are represented by percentage with total arboreal as cardinal number in arboreal, and in nonarboreal, with total taken unknown off. And ●○symbols indicate less than 1%.

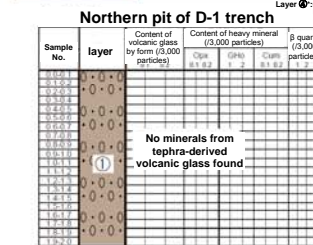
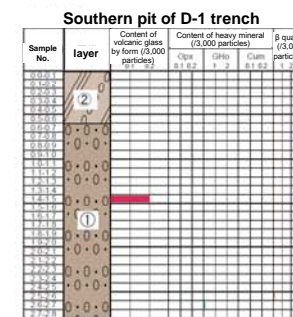
18-01, 26-03: layer②

As pollens are not only coniferous like pinus, cryptomeria and tsuga, but also broadleaved tree like quercus, it is similar to P2, it is estimated that it was warm comparatively .

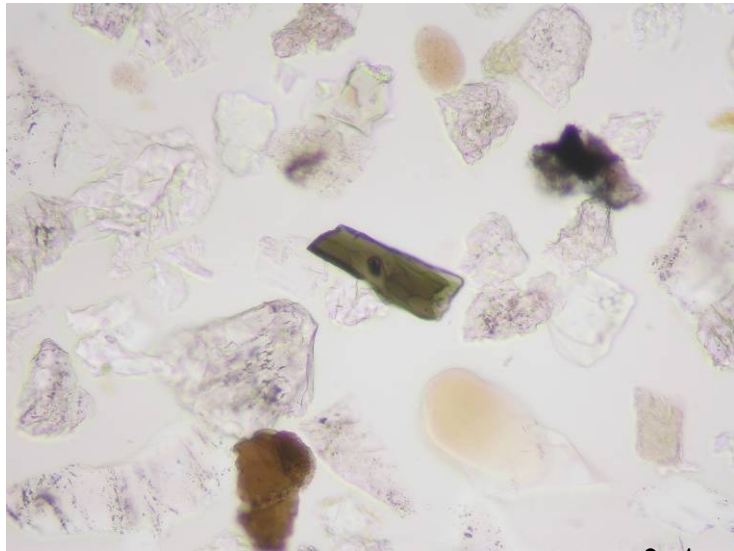
D-1 trench (result of tephra analysis)



Layer name	Facies
Layer ⑤	Sandy silt with gravel.
Layer ⑥	Mainly composed of gravel.
Layer ⑦	Sandy silt with gravel – silty sand with gravel.
Layer ⑧	Humic sandy silt-silty sand.
Layer ⑤ U (Upper part)	Mainly composed of silty gravel.
Layer ⑤ L (Lower part)	Mainly composed of silty gravel.
Layer ④	Distributed just beneath unconformity surface with undulation and denudation.
Layer ③	Mainly composed of gravel.
Layer ②	Sandy silt-silty sand.
Layer ①	Mainly composed of gravel.

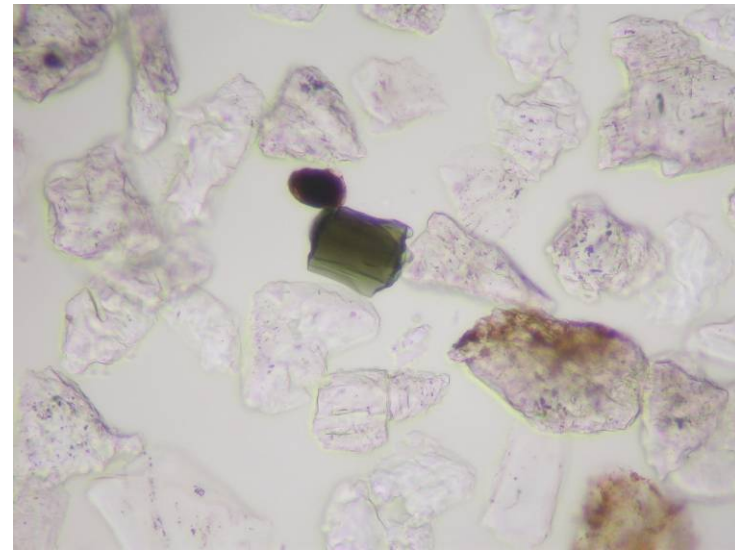


Tephra analysis(Continuous sampling at 10cm intervals)
 -The presence of DKP from Layer⑦ and K-Tz from upper part of Layer⑤ have been confirmed.
 -The presence of very few common hornblende is confirmed in lower part of layer⑤ and layer④.



0.1mm

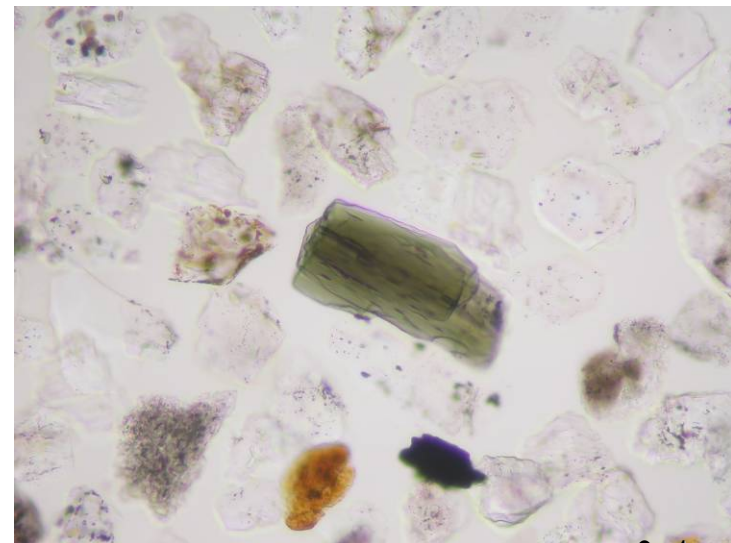
The hornblende included in the layer ③



0.1mm

The hornblende included in lower part of the layer ⑤

Idiomorphic hornblendes are included in Layer ③ and lower part of layer ⑤, just like the hornblende in Mihama tephra.



0.1mm

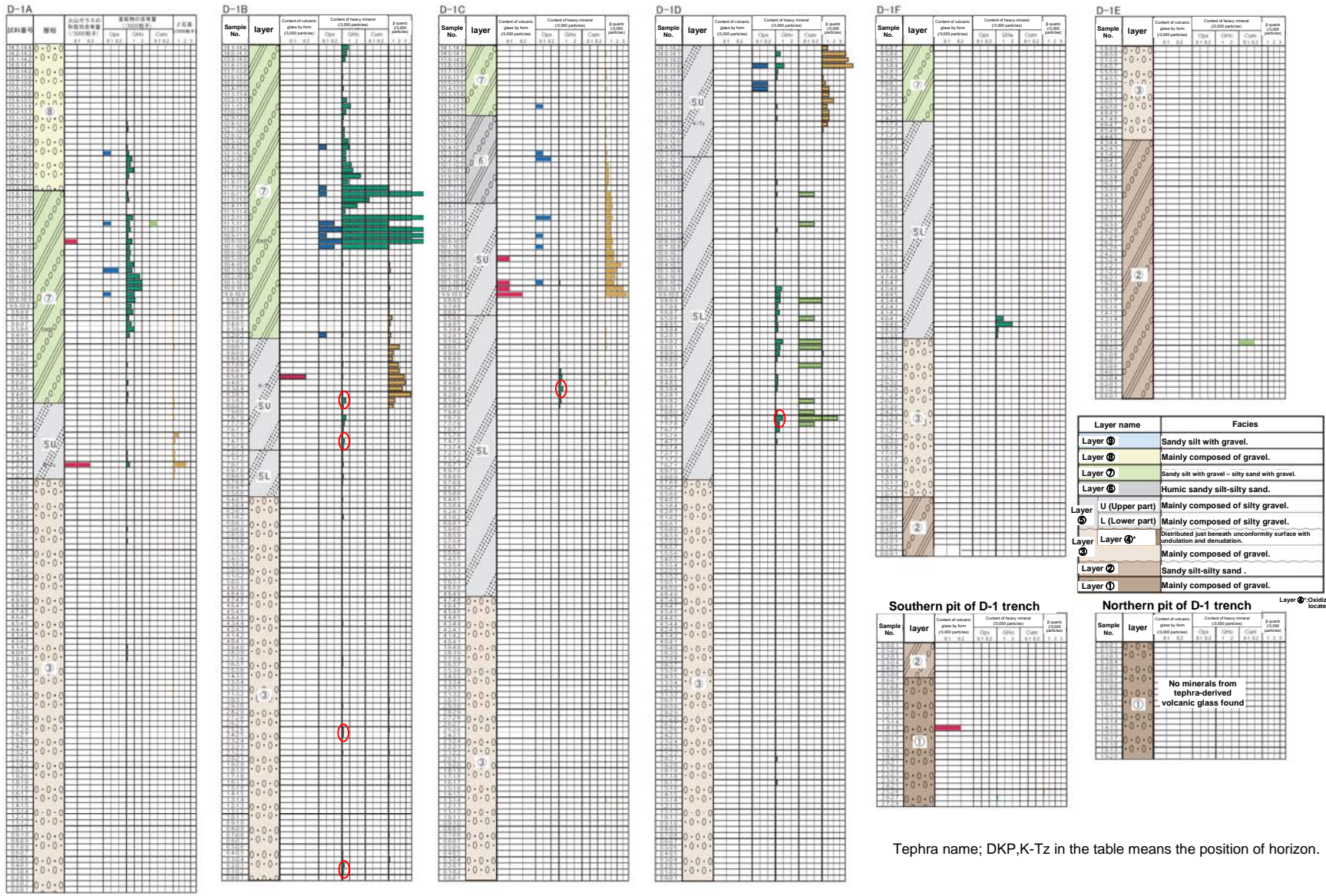
The hornblende of Mihama tephra

Presence or absence of hornblende in the basement rock in the site

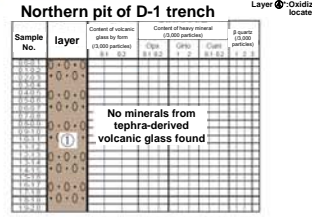
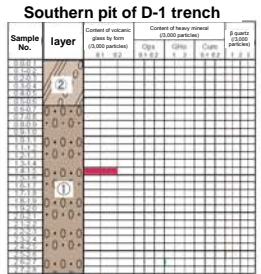
Name of rocks	Sample names	items	Name of minerals										total
			Quarts	Plagioclase	Potassium feldspar	Clinopyroxene	Orthopyroxene	Biotite	Muscovite	Opaque mineral	Smectite	Common hornblende	
Biolite granite	Gr-1	Number of counts	1367	891	1315	-	-	12	-	-	-	-	3585
		Content (%)	38.1	24.9	36.7	-	-	0.3	-	-	-	-	100
	Gr-2	Number of counts	906	560	884	-	-	28	-	0	-	-	2378
		Content (%)	38.1	24.8	36.6	-	-	1.2	-	0	-	-	100
Granite porphyry	Gp-1	Number of counts	911	500	719	-	-	53	-	5	-	-	2188
		Content (%)	41.6	22.9	32.9	-	-	2.4	-	0.2	-	-	100
	Gp-2	Number of counts	756	546	728	-	-	39	-	6	-	-	2075
		Content (%)	36.4	26.3	35.1	-	-	1.9	-	0.3	-	-	100
Aplite	Ap-1	Number of counts	1118	675	1264	-	-	24	6	13	-	-	3100
		Content (%)	36.1	21.8	40.8	-	-	0.8	0.2	0.4	-	-	100
	Ap-2	Number of counts	750	500	707	-	-	30	5	8	-	-	2000
		Content (%)	37.5	25.0	35.4	-	-	1.5	0.3	0.4	-	-	100
Dolerite	Do-1	Number of counts	-	1415	-	297	30	-	-	149	861	-	2752
		Content (%)	-	51.4	-	10.8	1.1	-	-	5.4	31.3	-	100
	Do-2	Number of counts	-	1182	-	108	32	-	-	109	569	-	2000
		Content (%)	-	59.1	-	5.4	1.6	-	-	5.5	28.5	-	100

- Mineral composition proportions are found from the observation of thin or polished rock slabs under the microscope regarding samples collected in the site
- Other trace components are granites such as zircon and apatite, and dolerite such as calcite and zeolite.
- As above, no basement rocks in the site include hornblende.

Sampling locations of main component analysis for the hornblende from the Layer③ and Layer⑤L



Layer name	Facies
Layer ①	Sandy silt with gravel.
Layer ②	Mainly composed of gravel.
Layer ③	Sandy silt with gravel – silty sand with gravel.
Layer ④	Humic sandy silt-silty sand.
Layer ⑤	Mainly composed of silty gravel.
Layer ⑥	Mainly composed of silty gravel.
Layer ⑦	Distributed just beneath unconformity surface with undulation and denudation.
Layer ⑧	Mainly composed of gravel.
Layer ⑨	Sandy silt-silty sand.
Layer ⑩	Mainly composed of gravel.

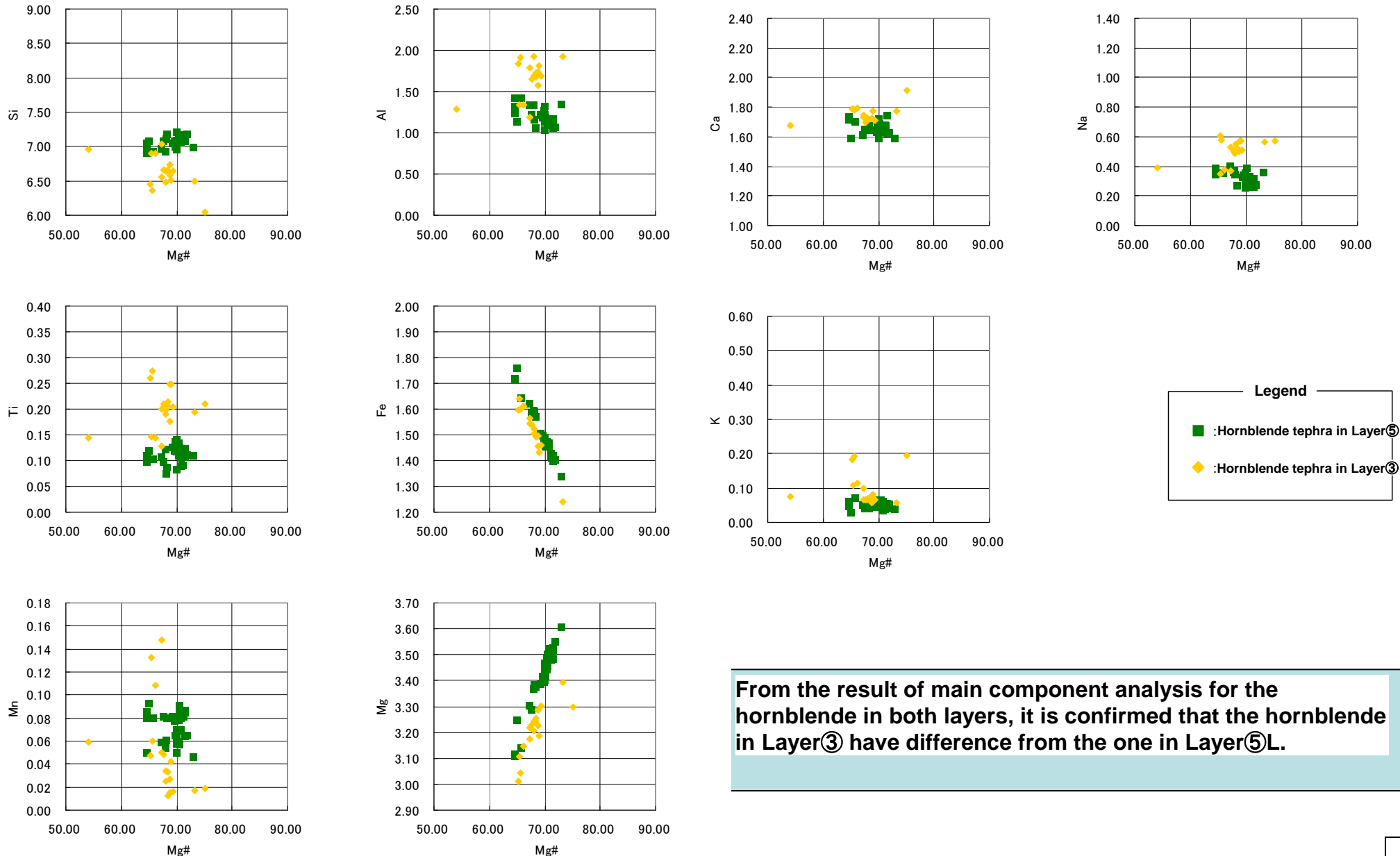


Layer ⑦: Oxidized zone of upper end of layer ⑥ located just beneath unconformity surface.

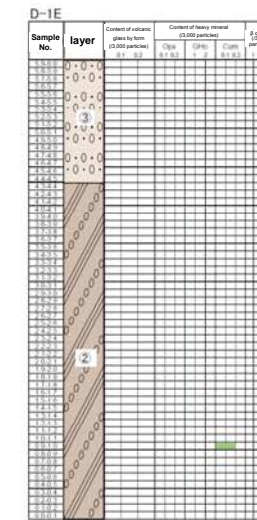
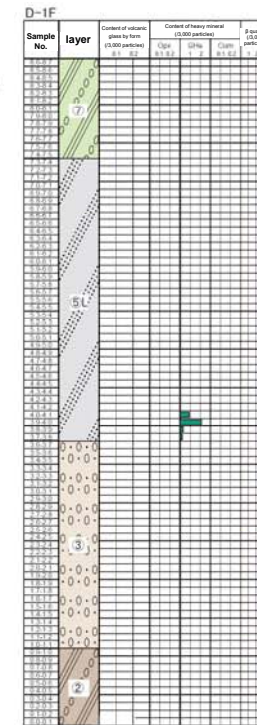
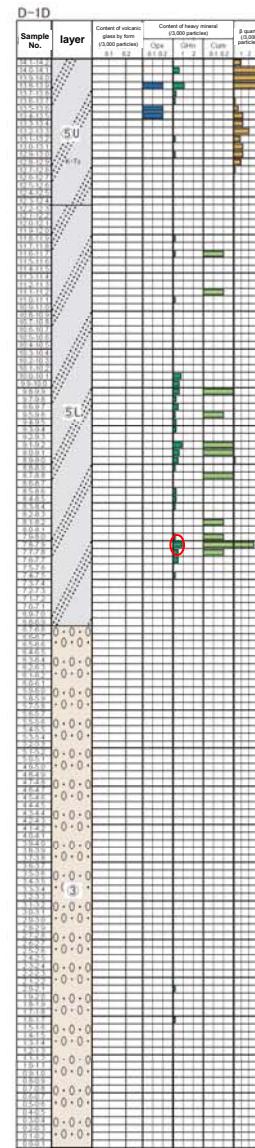
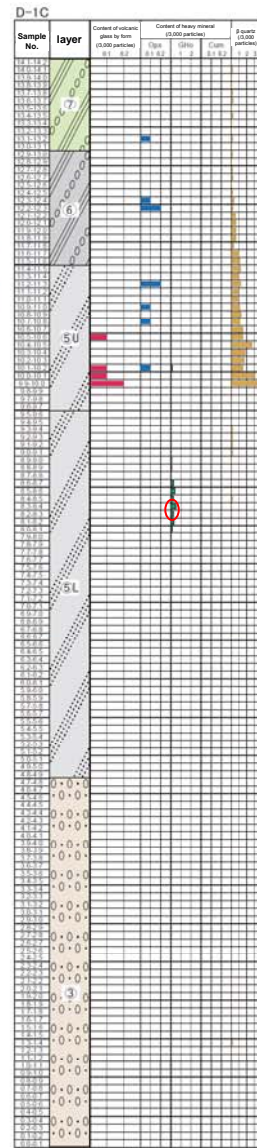
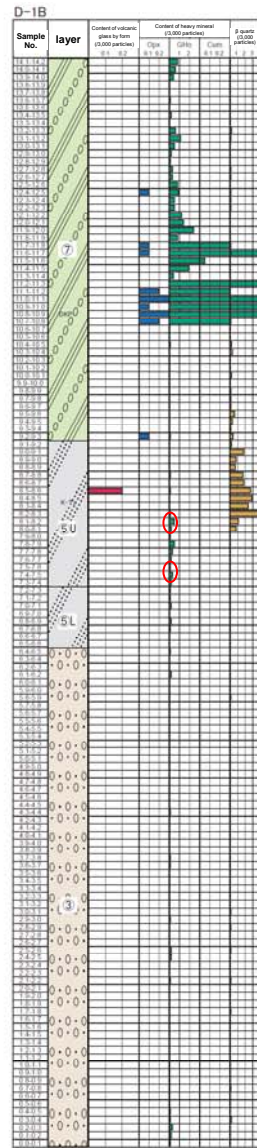
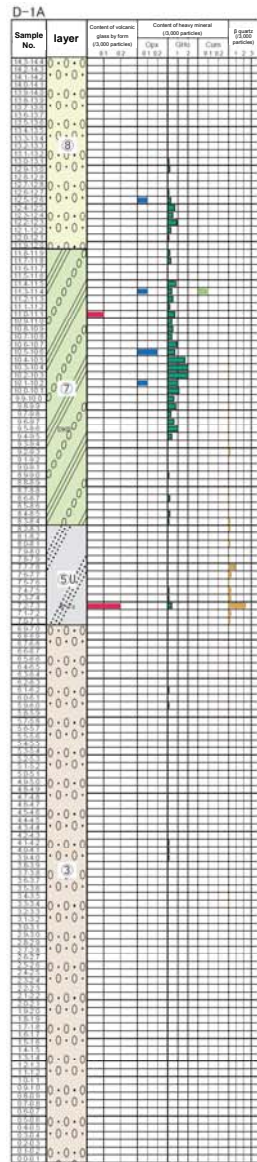
Tephra name; DKP, K-Tz in the table means the position of horizon.

The main component analyses are performed to confirm the difference between the common hornblende from the Layer③ and Layer⑤L. The sampling locations are circled in red.

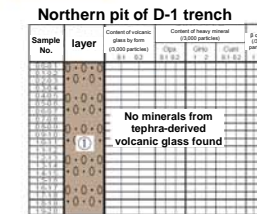
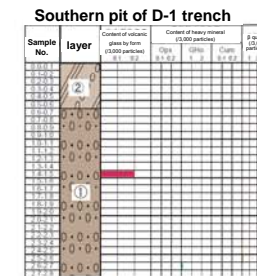
The result of main ingredient analysis of hornblende from lower part of layer ⑤ and layer ③



Sampling locations for main component analysis of the hornblende from Layer 5L.



Layer name	Facies
Layer ⑥	Sandy silt with gravel.
Layer ⑦	Mainly composed of gravel.
Layer ⑦	Sandy silt with gravel - silty sand with gravel.
Layer ⑧	Humic sandy silt-silty sand.
Layer ⑤ U (Upper part)	Mainly composed of silty gravel.
Layer ⑤ L (Lower part)	Mainly composed of silty gravel.
Layer ④	Distributed just beneath unconformity surface with undulation and denudation.
Layer ③	Mainly composed of gravel.
Layer ②	Sandy silt-silty sand.
Layer ①	Mainly composed of gravel.

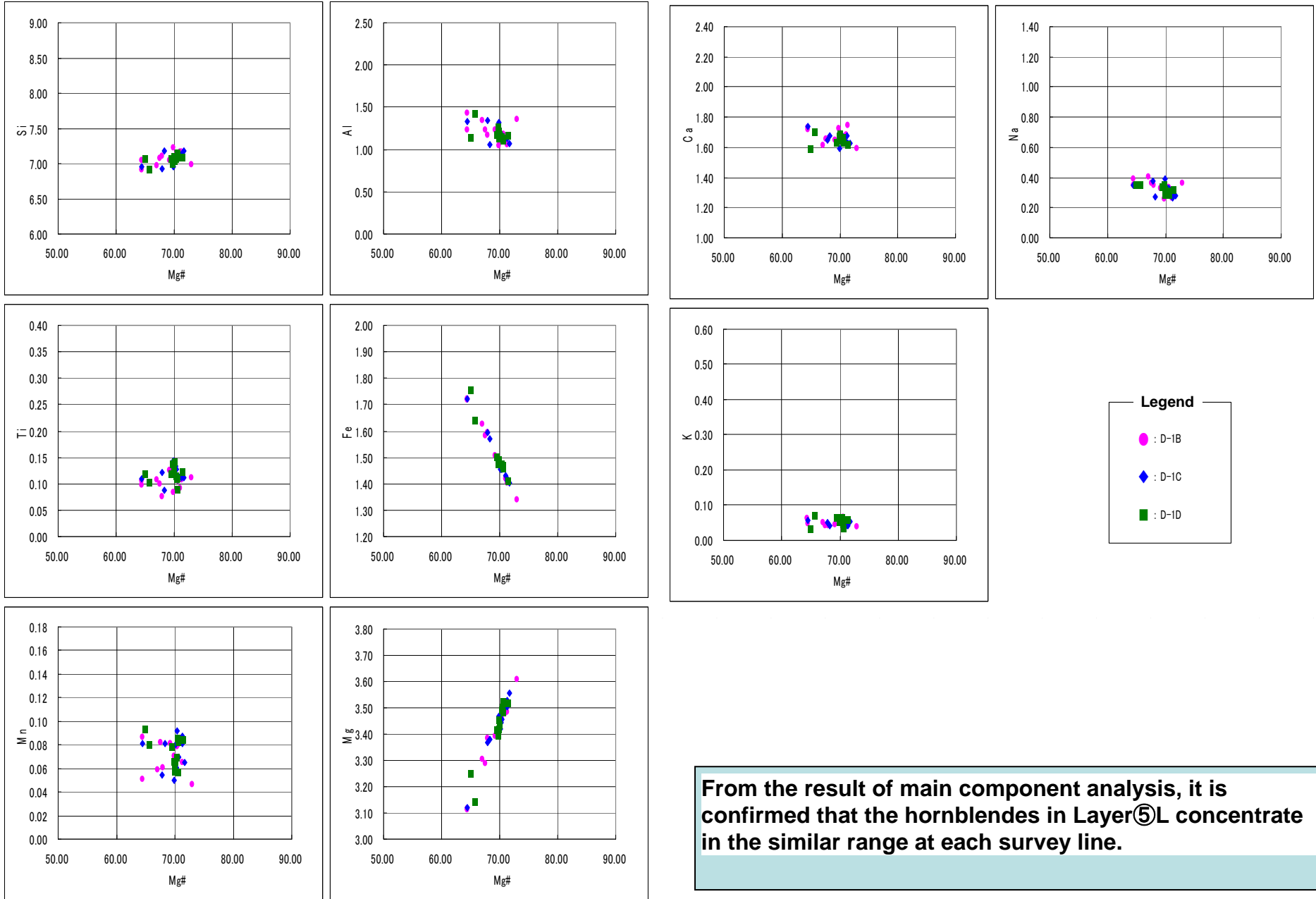


Layer ① - Oxidized zone of upper end of layer ②, located just beneath unconformity surface.

Tephra name; DKP, K-Tz in the table means the position of horizon.

The sampling locations for main component analyses of the hornblende from the Layer 5L are circled in red.

The result of main component analysis for the hornblende from each survey line of Layer⑤L



From the result of main component analysis, it is confirmed that the hornblendes in Layer⑤L concentrate in the similar range at each survey line.

[1] Around Sanbensan・Daisen

表 3.2-1

Volcano, Tephra	Symbol	year	Means	Facies	Distribution Volume	A	V	Note	Symbol	Main mineral	Volcano glass type	opx γ	ho, cum n_2	模式地・その他
大山荒田 ^{1), 3)}	DAP1			pfa	E (S) 50 km	3?	4-5		DAP1	ho, opx, (bi)		1.700-1.706	1.675-1.689	関金町荒田
Kikai-Tozuhara	K-Tz	95		afa(風化)				本文・表 3.1-1 参照。	K-Tz	qt	bw	1.496-1.499		八束村宮城
Ata	Ata	105~110		同上				本文・表 3.1-2 参照。	Ata	(opx)	bw	1.508-1.510	1.706-1.708	同上
Sanbekisuki	SK	110~115	ST	pfl, pfa	ENE 900 km 図 2.2-3	5	6	[古志原] ⁹⁾ , 本文参照。 漂着軽石は越前海岸, 能登・男鹿半島に分布 ^{17), 18)} 。	SK	bi; qt	pm	1.494-1.498 (1.497)		木次町寺領, 松江市古志原。

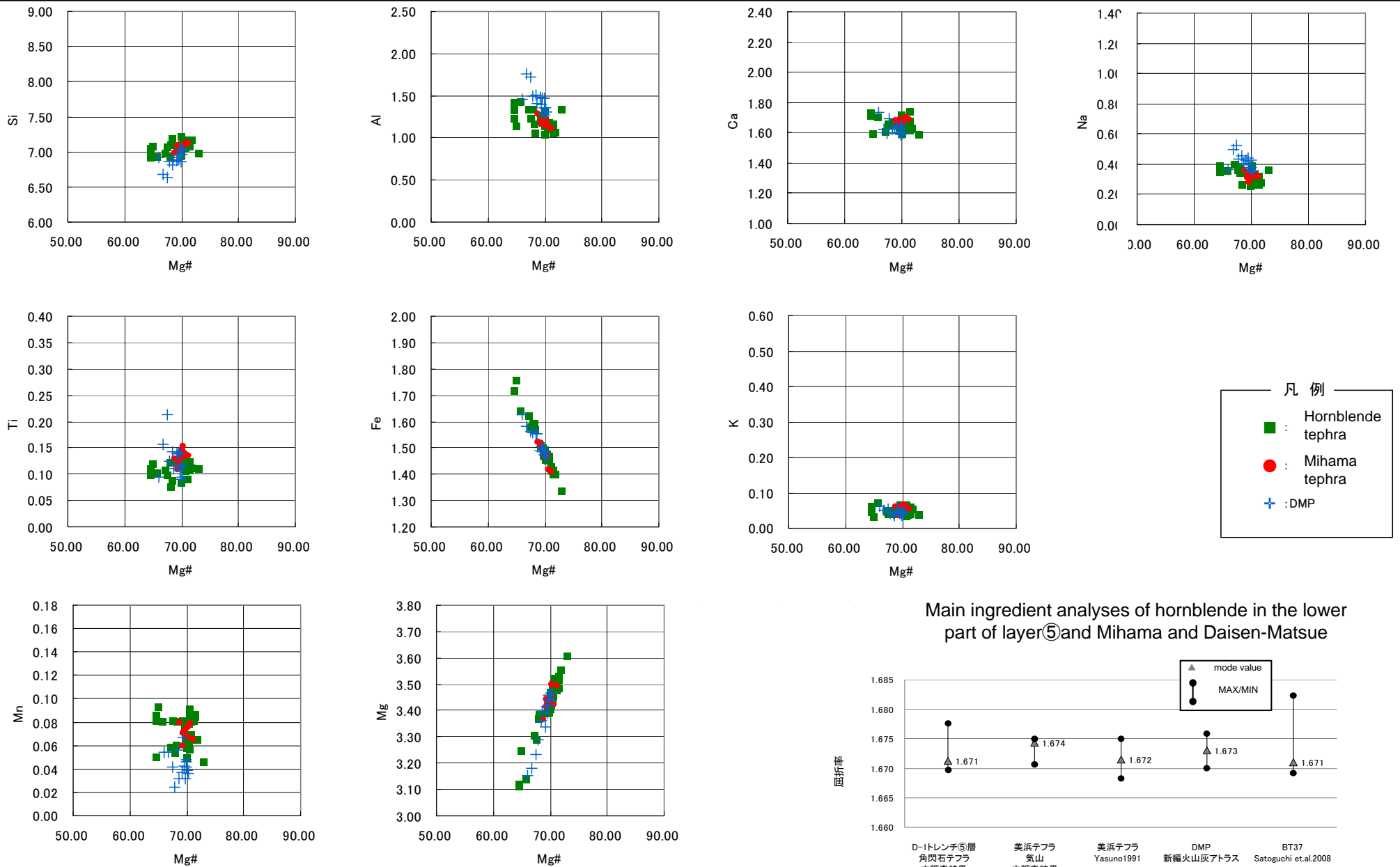
Volcano, Tephra	Symbol	year	Means	Facies	Distribution Volume	A	V	Note	Symbol	Main mineral	Volcano glass type	opx γ	ho, cum n_2	模式地・その他
Daisen-Hiruzenpara	DHP			pfa, pfl	E 200 km	4	5-6	pfl は [旧奈和] ¹⁹⁾ 。	DHP	ho, bi			1.673-1.679	八束村蒜山高校
Daisen-Matsue	DMP	<130	ST	pfa	W 80 km E 50 km? 図 3.2-1	4	5-6	直下に最終間氷期海成層 ⁷⁾ 。	DMP	ho, cum, (bi, opx)			1.670-1.676 (1.673) cum 1.656-1.664 (1.659)	米子市岡成上泉, 松江市古志原

1) 松井・井上 (1971), 2) 草野・中山 (1999), 3) 林 (1991), 4) 三浦・林 (1991), 5) 林・三浦 (1987), 6) 服部ほか (1983), 7) 町田 (1986), 14) 竹本ほか (1987), 15) 町田ほか (1985), 16) 津久井・棚山 (1981), 17) 豊塚ほか (1991), 18) 白石ほか (1992), 19) 荒川 (1984), Ooi (1992), 27) 加藤ほか (1996), 28) 佐藤・町田 (1996), 29) 愛媛ローム団研グループ (1969), 30) 宮瀬ほか (1999), 31) 石賀 (1997a), 32) 新井 (1979), 8) 津久井 (1984), 9) 堂淵ほか (2002), 10) 佐治ほか (1975), 11) 町田・新井 (1976), 12) 蒜山原団研グループ (1973), 13) 林・三浦 (1986), 20) 野村・田中 (1987), 21) 竹村・榎原 (1987), 22) 竹本 (1991), 23) 町田ほか (1991), 24) 福沢・Zolitschka (2000), 25) 吉川ほか (1986), 26) 石賀 (1997b), 33) 木村ほか (1999), 34) 福岡・松井 (2002), 35) 野村ほか (1995), 36) 岡田・石賀 (2000)。

According to “Atlas of Tephra in and around Japan”, tephtras located lower than K-Tz(Kikai-Tozuhara) in this region are Ata, Sanbekisuki, Daisen-Hiruzenpara, Daisen-Matsue in order from upper.
In other papers, Mihama-Tephra(Yasuno1991) and BT37-Tephra(Satoguchi et al.2008, Nagahashi et al.2004) are listed.

(Reference)
 ・Yasuno, T., 1991, Discovery of Molluscan Fossils and a Tephra Layer from the Late Pleistocene Kiyama Formation in West of Fukui Prefecture, Central Japan, Bull.Fukui Mus. Nat.Hist., No.38:9-14
 ・Satoguchi, Y. et al., 2008, The Middle Pleistocene to Holocene tephrostratigraphy of the Takashima-oki core from Lake Biwa, central Japan, Journal of Geosciences, Osaka City University, Vol.51, Art. 6, p.47-58
 ・Machida, H, Arai, F., 2003, Atlas of Tephra in and around Japan, University of Tokyo Press
 ・長橋良隆他, 2004, 近畿地方およびハッテ岳山麓における過去43万年間の広域テフラの層序と編年 - EDS分析による火山ガラス片の主要成分化学組成 - , 第四紀研究, 43, 15-35

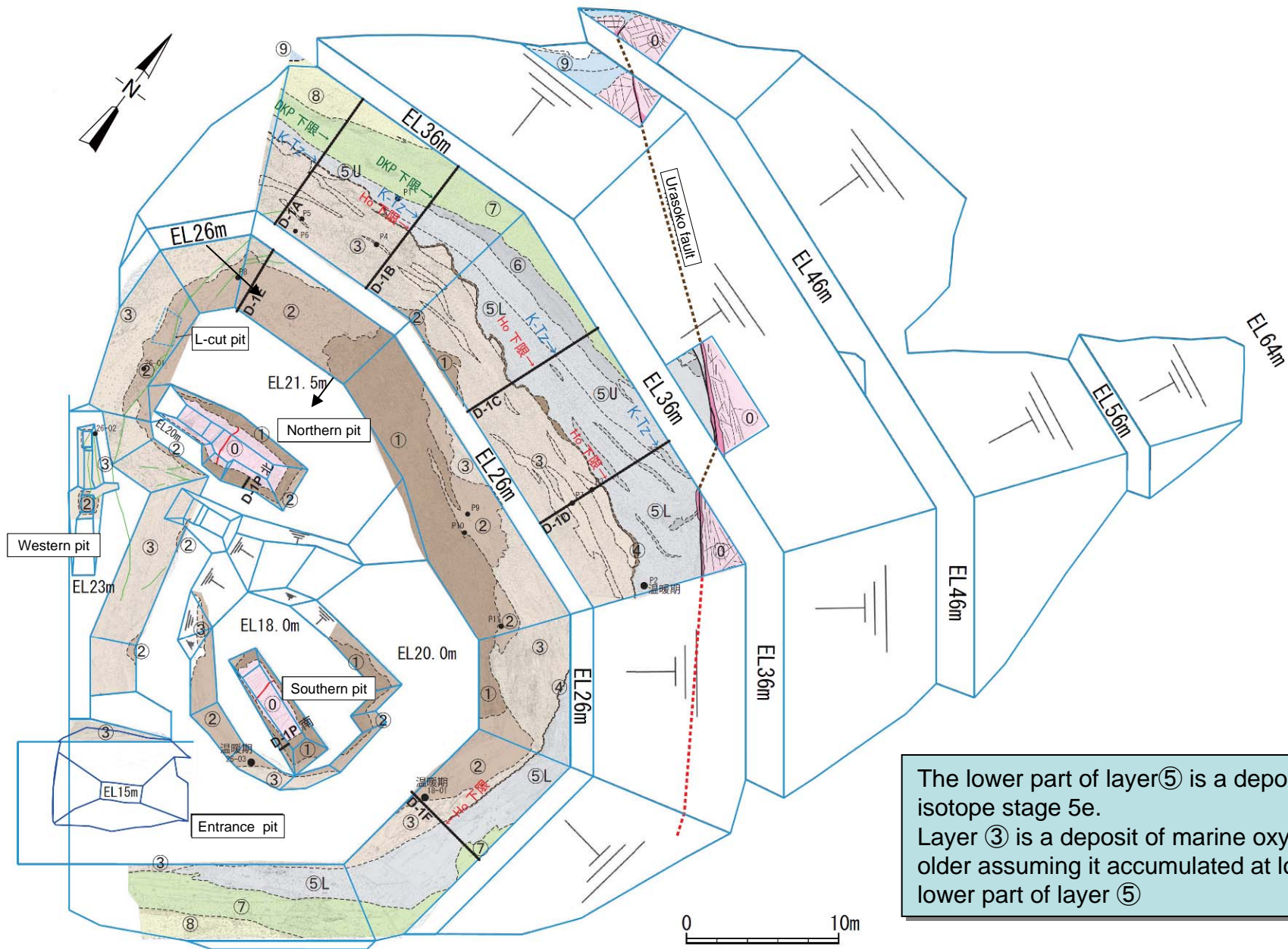
Refractive index and main ingredient analyses of hornblende in the lower part of layer⑤ and Mihama and Daisen-Matsue



Comparing main components analyses of hornblende of layer⑤L with the ones of Daisen-Matsue and Mihama, the hornblendes of the lower part of layer⑤ and Mihama have close resemblances.

Refractive index of hornblende in the lower part of layer⑤ and Mihama and Daisen-Matsue

D-1 trench geological plan drawing



The lower part of layer⑤ is a deposit of marine oxygen-isotope stage 5e.
 Layer ③ is a deposit of marine oxygen-isotope stage 6 or older assuming it accumulated at lower colder period than lower part of layer ⑤

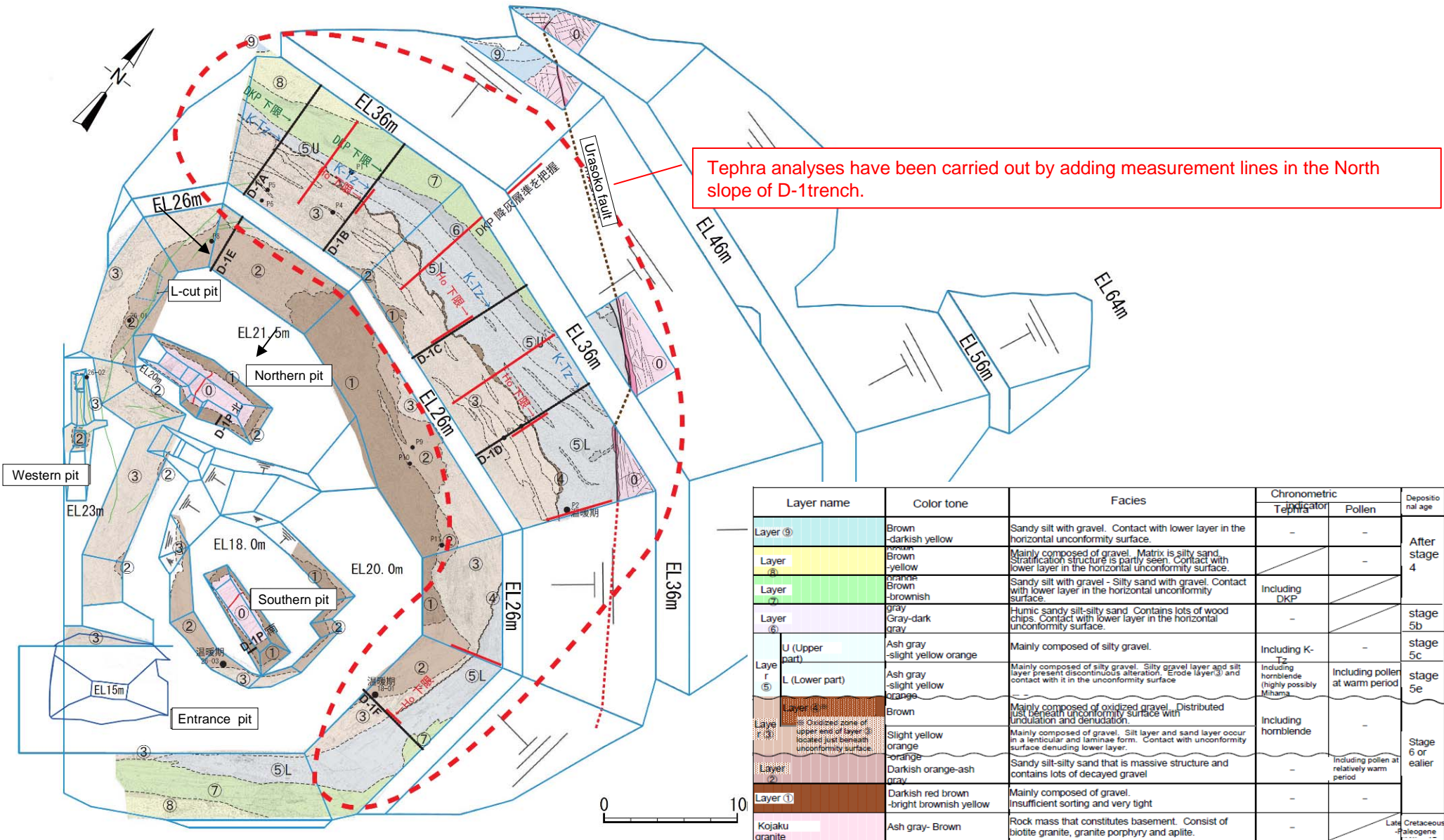
Geologic stratigraphic sequence of D-1 trench

Layer name		Color tone	Facies	Chronometric indicator		Depositional age
				Tephra	Pollen	
Layer ⑨		Brown -darkish yellow brown	Sandy silt with gravel. Contact with lower layer in the horizontal unconformity surface.	-	-	After stage 4
Layer ⑧		Brown -yellow orange	Mainly composed of gravel. Matrix is silty sand. Stratification structure is partly seen. Contact with lower layer in the horizontal unconformity surface.	/	-	
Layer ⑦		Brown -brownish gray	Sandy silt with gravel - Silty sand with gravel. Contact with lower layer in the horizontal unconformity surface.	Including DKP	/	
Layer ⑥		Gray-dark gray	Humic sandy silt-silty sand. Contains lots of wood chips. Contact with lower layer in the horizontal unconformity surface.	-	/	stage 5b
Layer ⑤	U (Upper part)	Ash gray -slight yellow orange	Mainly composed of silty gravel.	Including K-Tz	-	stage 5c
	L (Lower part)	Ash gray -slight yellow orange	Mainly composed of silty gravel. Silty gravel layer and silt layer present discontinuous alteration. Erode layer ③ and contact with it in the unconformity surface	Including hornblende (highly possibly Mihama)	Including pollen at warm period	stage 5e
Layer ④*		Brown	Mainly composed of oxidized gravel. Distributed just beneath unconformity surface with undulation and denudation.	Including hornblende	-	Stage 6 or earlier
Layer ③	×	Slight yellow orange -orange	Mainly composed of gravel. Silt layer and sand layer occur in a lenticular and laminae form. Contact with unconformity surface denuding lower layer.			
Layer ②		Darkish orange-ash gray	Sandy silt-silty sand that is massive structure and contains lots of decayed gravel	-	Including pollen at relatively warm interval	
Layer ①		Darkish red brown -bright brownish yellow	Mainly composed of gravel. Insufficient sorting and very tight	-	-	
Kojaku granite		Ash gray- Brown	Rock mass that constitutes basement. Consist of biotite granite, granite porphyry and aplite.	-	/	Late Cretaceous - Paleogene

Lower part of layer ⑤ is a deposit of marine oxygen-isotope stage 5e.

Layer ③ is a deposit of marine oxygen-isotope stage 6 or older assuming it accumulated at lower colder period than lower part of layer ⑤

Survey plan on evaluation of activity of the D-1 shatter zone (including the G fault) and the K fault



For further credibility, additional analyses have been carried out with more survey lines in the D-1 trench