

without discoloring on the mound of Ore Showing E4 and E9. This may suggest a younger generation of these ore showings. The ore showings other than above, including ones partly observed by FDC and BMS, have an extension of more or less 50m with a height of 5-10m.

A total of 11 large ore showings with mound extending more than 100m were found in the Triple Junction Area. Among them, four ore showings occur within a small area between 16° 57.5' E and 16° 57.6' E on the east side of the gentle hill in the West Area, while the other seven are found scattered over the foot of the Eastern Ridge in the East Area.

Chimneys usually occur on the mound, however, no active chimney was found by the sea floor observation of FDC and BMS. This corresponds to the fact that no conspicuous bio-community was observed around the chimneys. Considering the occurrences of some of the well-preserved chimney without weathering, the hydrothermal activity continued until quite reentry. The unclearness of the sea water close to some of the mounds and the temperature anomaly obtained in the West Area by the 1999 survey suggest an existence of active chimney in the area.

3-3-3 Sampling by LC and MC

LC sampling was carried out at twenty sites for obtaining the information of the surface of the sea bottom to understand distribution of the mineralization zone. The results of MC sampling conducted for the environmental survey is, also, given here together with LC sampling results. The sampling results and sampling location of LC and MC are given in Table 3-3-3-1 and Figure 3-3-3-1, Figure 3-3-3-2 shows correlation of the LC samples. The columnar chart of LC and MC and photographs of the sea floor, simultaneously taken at sampling, are given in Appendices 2 and 3. The results of heat flow measurement, conducted simultaneously with LC sampling are given in Appendix 13.

3-3-3-1 Description of LC and MC samples

(1) 01SFMC01

Location: 16° 57.5053'S, 173° 55.0994'E

Depth: 1,980m

Core Length: 0cm

Sea Floor Photograph: not obtained.

Sampling was conducted for collecting the sediments overlying ore showing. Sample was not collected because of exposure of the bedrock.

Table 3-3-1 Results of LC and MC Surveys

No.	Sample No.	Area	Location		depth (m)	Core- length (cm)	weight (kg)	Description	Remarks
			latitude	longitude					
1	01SFMC01	West Area	16°57.5053' S	173°55.0994' E	1,980	0	—	No sample	
2	01SFMC02	West Area	16°57.5184' S	173°55.1005' E	1,980	0	—	No sample	The same location as MC02
3	01SFMC03	West Area	16°57.5286' S	173°55.1029' E	1,980	0	—	No sample	
4	01SFLC07	West Area	16°57.5782' S	173°55.0956' E	1,983	0	0.10	Fragment of massive sulfide(chalcopyrite, pyrite, Sphalerite)	Near W7
5	01SFLC08	West Area	16°57.5770' S	173°55.1040' E	1,982	55	2.80	Black glass and fragment of basalt	The same location as LC07
6	01SFLC09	West Area	16°57.3980' S	173°55.0496' E	1,980	95	11.30	Reddish clay with layer of Mn oxide	Near W1
7	01SFMC04	West Area	16°57.3957' S	173°55.0495' E	1,978	10	—	Reddish clay	The same location as LC09
8	01SFLC10	East Area	16°57.5768' S	173°55.2335' E	1,989	0	0.05	Fragment of basalt	
9	01SFLC11	West Area	16°57.6540' S	173°55.0201' E	1,981	10	1.10	Basalt and fragment of black glass	
10	01SFLC12	Western Ridge	16°57.5692' S	173°54.5972' E	1,895	110	12.90	Calcareous reddish or gray-reddish clay	
11	01SFMC05	Western Ridge	16°57.5690' S	173°54.5937' E	1,895	20	—	Calcareous reddish or gray-reddish mud sediment	The same location as LC12
12	01SFLC13	West Area	16°57.6610' S	173°55.0496' E	1,980	0	0.05	Fragment of basalt	
13	01SFLC14	Southern part of West Area	16°57.9039' S	173°55.0056' E	1,990	15	0.50	Fragment of black glass	
14	01SFLC15	West Area	16°57.6339' S	173°55.0153' E	1,981	95	12.25	Reddish clay with Mn oxide and black glass	Near ore showing
15	01SFMC06	West Area	16°57.6444' S	173°55.0206' E	1,981	8	—	Reddish clay with Mn oxide	Between LC11 and LC15
16	01SFMC07	West Area	16°57.6258' S	173°55.0304' E	1,978	10	—	Reddish clay	The same location as MC06
17	01SFLC16	East Area	16°57.7066' S	173°55.3375' E	1,993	10	0.35	Fragment of basalt covered by black glass	Near E9
18	01SFLC17	East Area	16°57.7501' S	173°55.4309' E	1,988	10	0.85	Massive sulfide(φ10cm) ,Pyrite, Chalcopyrite, Sphalerite	E13
19	01SFLC18	East Area	16°57.8473' S	173°55.2092' E	1,989	5	0.44	Fragment of basalt covered by Mn oxide	E16
20	01SFLC19	East Area	16°57.5580' S	173°55.3904' E	1,997	0	0.05	Fragments of basalt	Near E4
21	01SFLC20	East Area	16°57.8598' S	173°55.3068' E	1,989	0	0.01	Fragments of black glass(φ5cm), quartz, thin vein with pyrite	Near 7-2
22	01SFLC21	Eastern part of East Area	16°57.6209' S	173°55.6324' E	1,951	25	0.50	Basalt, mudstone and fragments of Mn oxide, Pyrite grains	
23	01SFLC22	Eastern part of East Area	16°57.8522' S	173°55.6436' E	1,950	20	0.65	Basalt and fragment of black glass	
24	01SFLC23	Southern part of East Area	16°57.9789' S	173°55.5767' E	1,977	0	0.01	Basalt and fragments of black glass	
25	01SFLC24	West Area	16°57.7340' S	173°55.1598' E	1,987	0	0.01	Fragments of black glass, Mn oxide, pyrite grain	Near 6-1
26	01SFLC25	West Area	16°57.7239' S	173°55.0281' E	1,979	0	0.00	Fragments of black glass adhere mud including Mn oxide	
27	01SFLC26	Southern part of West Area	16°57.8933' S	173°54.9548' E	1,993	25	0.55	Reddish mud with Mn oxide	

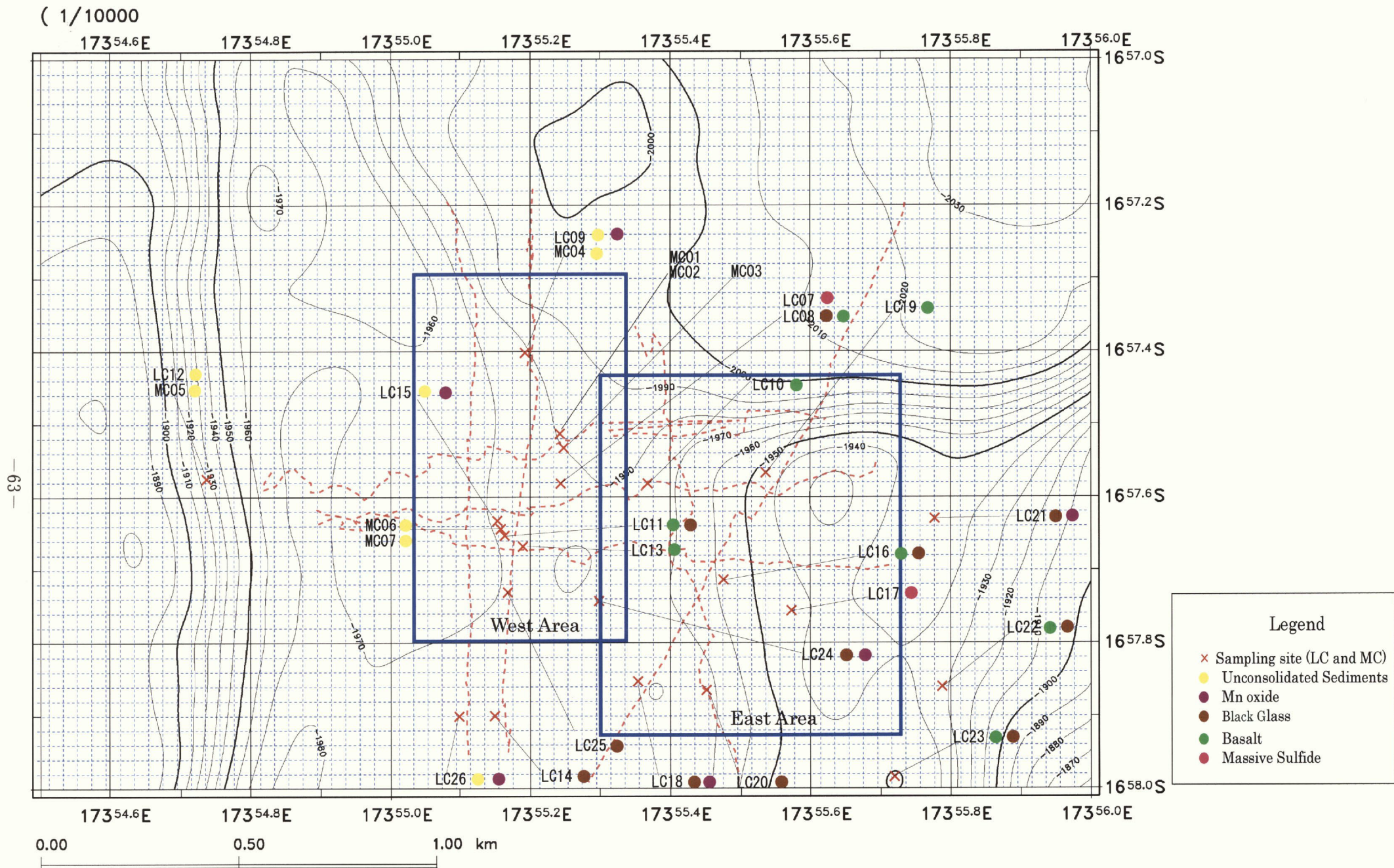


Figure 3-3-3-1 Location Map of LC and MC site

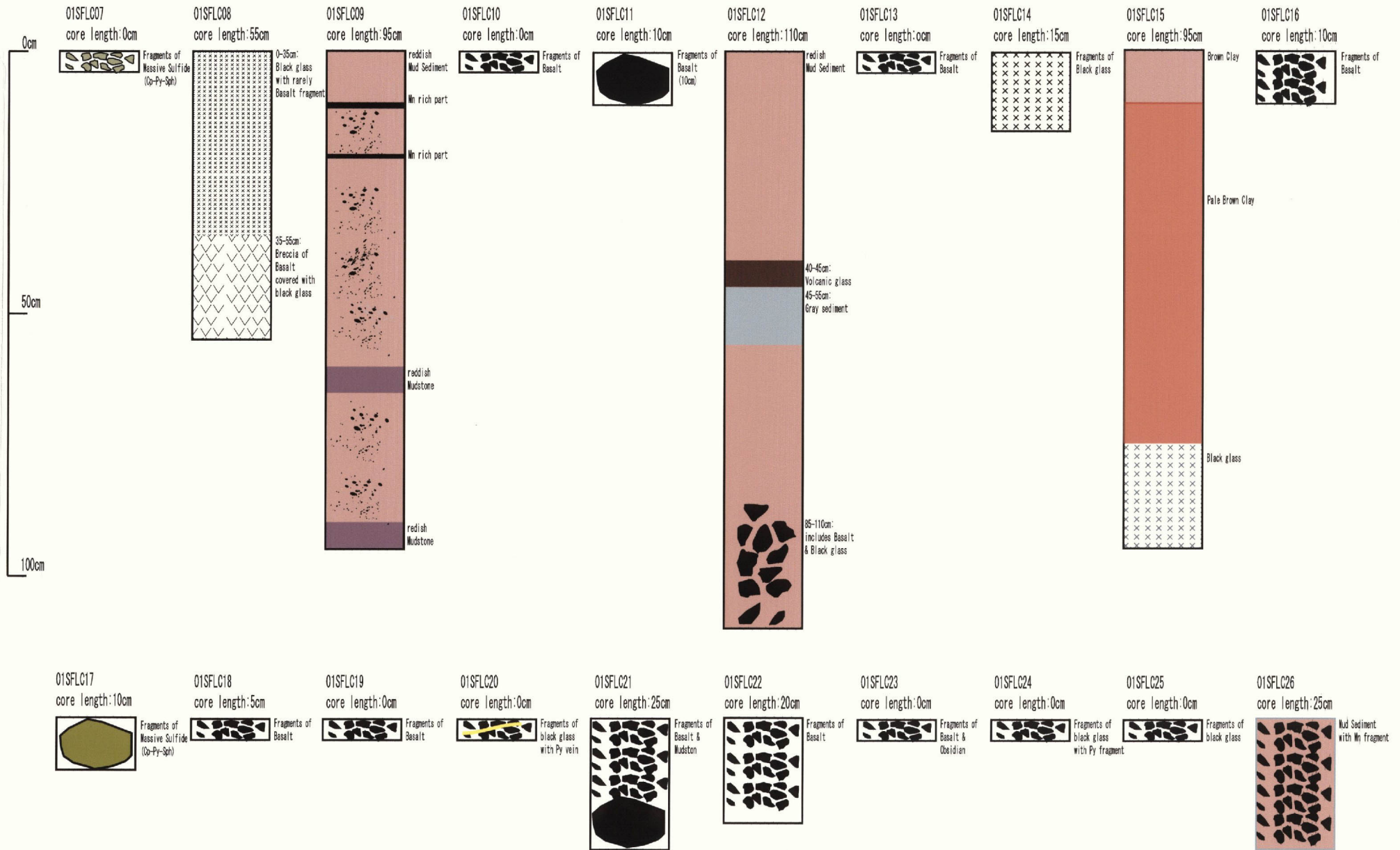


Figure 3-3-3-2 Correlation of LC samples

(2) 01SFMC02

Location: 16° 57.5184'S, 173° 55.1005'E

Depth: 1,980m

Core Length: 0cm

Sea Floor Photograph: not obtained.

Sampling was conducted for collecting the sediments overlying ore showing. Sample was not collected because of exposure of the bedrock.

(3) 01SFMC03

Location: 16° 57.5286'S, 173° 55.1029'E

Depth: 1,980m

Core Length: 0cm

Sea Floor Photograph: not obtained.

Sampling was conducted for collecting the sediments overlying ore showing. Sample was not collected because of exposure of the bedrock.

(4) 01SFLC07

Location: 16° 57.5782'S, 173° 55.0956'E

Depth: 1,983m

Core Length: 0cm

Sea Floor Photograph: not obtained.

Sampling was conducted at the site near Ore Showing W7 for collecting the sediments overlying ore showing. Few fragments of massive sulfides, 0.5 to 4cm across, were collected. An existence of mound at the site is expected.

(5) 01SFLC08

Location: 16° 57.5770'S, 173° 55.1040'E

Depth: 1,982m

Core Length: 55cm

Sea Floor Photograph: not obtained.

Sampling was conducted at the site near 01SFLC07 for collecting the sediments overlying ore showing. 0-35cm consists of fragments of black glass, 1-2cm across and fragments of basalt, 3-5cm across were collected between 35-55cm. Basalt is blackish gray, fine grained, compact rock and some of the fragments have black glass on surface.

(6) 01SFLC09

Location: 16° 57.3980'S, 173° 55.0496'E

Depth: 1,980m

Core Length: 95cm

Sea Floor Photograph: Unconsolidated sediments with cobbles of few cm across cover the sea floor.

Sampling was conducted at the site near Ore Showing W1 for collecting the sediments overlying ore showing. The collected sample is brown clay (5YR3/2-10YR4/4). It has 3 to 5mm thick black stripes consisting of Mn oxides, suggesting hydrothermal activity near the site. Deeper than 20cm, it shows brighter color with oxidized patches of reddish brown color, 2-3cm across.

(7) 01SFLC04

Location: 16° 57.3957'S, 173° 55.0495'E

Depth: 1,978m

Core Length: 10cm

Sea Floor Photograph: The sea floor is covered by unconsolidated sediments and pillow lava boulders of 50cm across.

MC sampling was conducted at the site of 01SFLC09 for collecting the sediments. The brown clay (5YR3/2) same as 01SFLC09 was collected.

(8) 01SFLC10

Location: 16° 57.5768'S, 173° 55.2335'E

Depth: 1,989m

Core Length: 0cm

Sea Floor Photograph: not obtained

Sampling was conducted for collecting unconsolidated sediments distributed slightly away from ore showing. Only basalt fragments of 1-4cm across were collected. The basalt is glassy, fine grained and compact with brownish color by oxidation.

(9) 01SFLC11

Location: 16° 57.6540'S, 173° 55.2001'E

Depth: 1,981m

Core Length: 10cm

Sea Floor Photograph: The sea floor is covered by unconsolidated sediments and basalt cobbles

Sampling was conducted for collecting unconsolidated sediments distributed slightly away from ore showing. Fragments of basalt, 10cm across, and black glass of 0.5-1cm were collected. The basalt is blackish gray, fine and compact. The surface of it is covered by black glass of a few cm thick.

(10) 01SFLC12

Location: 16° 57.5692'S, 173° 54.5972'E

Depth: 1,895m

Core Length: 110cm

Sea Floor Photograph: The sea floor is covered by unconsolidated sediments with scattered distribution of basalt pebbles, 1-2cm across.

The sampling was conducted in the flat area on the top of the Western Ridge. Calcareous clay was collected. It changes color: brown (5YR3/3, 0-40cm), pinkish gray (7.5YR7/2, 45-55), grayish brown (10Y/R5/2, 55-110cm). A layer rich in sand-size glass occurs at 40-45cm.

(11) 01SFMC05

Location: 16° 57.5690'S, 173° 54.5937'E

Depth: 1,895m

Core Length: 20cm

Sea Floor Photograph: Unconsolidated sediments cover the sea floor.

MC sampling was conducted at the same site as 01SFLC12 and brown (5YR3/3) calcareous clay was collected in the flat area on the top of the western ridge. Calcareous clay was collected.

(12) 01SFLC13

Location: 16° 57.6610'S, 173° 55.0496'E

Depth: 1,980m

Core Length: 0cm

Sea Floor Photograph: Basalt with thin cover of unconsolidated sediments.

Sampling was conducted for collecting sediments close to ore showing. Few angular black glass and basalt fragments of 0.5 to 2cm across were collected.

(13) 01SFLC14

Location: 16° 57.9039'S, 173° 55.0056'E

Depth: 1,990m

Core Length: 15cm

Sea Floor Photograph: Pillow lava covered by thin sediments is observed.

Sampling was conducted for collecting sediments close to ore showing. Few angular black glass fragments of 0.5 to 6cm across were collected.

(14) 01SFLC15

Location: 16° 57.6339'S, 173° 55.0153'E

Depth: 1,981m

Core Length: 95cm

Sea Floor Photograph: Unconsolidated sediments covers the area and a boulder of basalt 2m across is observed.

Sampling was conducted for collecting sediments close to ore showing. Brown (5YR3/2) clay with 2mm thick Mn oxides on the top was collected between the surface to 10cm deep and followed by pale brown (10YR6/3) clay from 10 to 75cm. Below the pale brown clay, 75-95cm, fragments of black glass, 2-5cm across were collected. The thin coverage of Mn oxides on the surface suggest an existence of hydrothermal activity close by the sampling site and thickness of the unconsolidated sediments seems to be around 75cm around the sampling sites.

(15) 01SFMC06

Location: 16° 57.6444'S, 173° 55.0206'E

Depth: 1,981m

Core Length: 8cm

Sea Floor Photograph: Boulders of 1m across were observed covered by thin sediments.

MC sampling was conducted for collecting sediments close to ore showing. Brown (5YR3/2) clay with 5mm thick Mn oxides on the top was collected. A fragment of black glass, 6cm across, with Mn oxides coating was collected together with brown clay.

(16) 01SFMC07

Location: 16° 57.6258'S, 173° 55.0304'E

Depth: 1,978m

Core Length: 10cm

Sea Floor Photograph: The sea floor is covered by unconsolidated sediments with few basalt cobbles

Sampling was conducted close to 01SFMC06 site and 10cm long brown clay sample was collected.

(17) 01SFLC16

Location: 16° 57.7066'S, 173° 55.3375'E

Depth: 1,993m

Core Length: 10cm

Sea Floor Photograph: The sea floor is occupied sheet lava.

Sampling was conducted near the Ore Showing E9 to know extension of the ore showing. Basalts fragments of 2-5cm across were collected. The basalt is blackish gray, compact, aphyric and is covered by black glass on its surface.

(18) 01SFLC17

Location: 16° 57.7501'S, 173° 55.4309'E

Depth: 1,988m

Core Length: 10cm

Sea Floor Photograph: The photograph shows a part of reddish brown chimney.

Sampling was conducted near the Ore Showing E9 to know distribution of the ore showings in the East Part. A 10cm across fragment of massive sulfide ore, possibly a fragment of chimney, was collected. It consists of fine grains of pyrite, chalcopyrite, sphalerite and marcasite.

(19) 01SFLC18

Location: 16° 57.8473'S, 173° 55.2092'E

Depth: 1,989m

Core Length: 5cm

Sea Floor Photograph: not obtained

Sampling was conducted near the Ore showing E16 to know distribution of ore showings in the East Part. Two basalt fragments of 5cm across were collected. The basalt is blackish gray, fine-grained, aphyric and vesicular. Mn coating on the surface of it suggests an existence of hydrothermal mineralization near the sampling site.

(20) 01SFLC19

Location: 16° 57.5580'S, 173° 55.3904'E

Depth: 1,997m

Core Length: 0 cm

Sea Floor Photograph: The sea floor is covered by unconsolidated sediments with basalt cobbles of 10-20cm across.

Sampling was conducted near the Ore showing E4 to know distribution of ore showings in the East Part. Few basalt fragments of 1-3cm across were collected. The basalt is blackish gray, fine-grained and slightly vesicular.

(21) 01SFLC20

Location: 16° 57.8598'S, 173° 55.3068'E

Depth: 1,989m

Core Length: 0 cm

Sea Floor Photograph: Sheet lava, partly altered to brownish color, occupies the sea floor partly

Sampling was conducted near the Ore showing 7-2 to know distribution of ore showings in the East Part. Two black glass fragments of 0.5cm across were collected. Quartz films with pyrite in the black glass suggest existence of ore showing nearby.

(22) 01SFLC21

Location: 16° 57.6209'S, 173° 55.6324'E

Depth: 1,951m

Core Length: 25 cm

Sea Floor Photograph: Basalt lava, partly altered to reddish brown color, occurs on slop.

Sampling was conducted on a flat terrace plane of the Eastern Ridge. Fragments of basalt, mudstone and Mn oxides of 1-10cm across were collected. The basalt with 5mm thick black glass layer on the surface is blackish gray, fine-grained, aphyric and slightly vesicular. Fragments of grayish brown, soft mudstone and platy fragments of 5mm thick Mn oxides were, also, collected. The sand grains collected together with these fragments contain pyrite and reddish oxidized grains. The Mn oxides fragments and pyrite grains suggest existence of ore showing nearby the sampling site.

(23) 01SFLC22

Location: 16° 57.8522'S, 173° 55.6436'E

Depth: 1,950m

Core Length: 20 cm

Sea Floor Photograph: Brecciated basaltic lava occurs on a slope.

Sampling was conducted on a flat terrace plane of the Eastern Ridge. Basalt and black glass fragments of 1-7cm across were collected. The basalt is blackish gray, fine-grained and vesicular and it has a 5cm thick layer of black glass on its surface.

(24) 01SFLC23

Location: 16° 57.9789'S, 173° 55.5767'E

Depth: 1,977m

Core Length: 0 cm

Sea Floor Photograph: Brecciated basaltic lava occurs on a slope.

Sampling was conducted on a flat terrace plane of the Eastern Ridge. Basalt and black glass fragments of 0.5-1cm across were collected. The basalt is blackish gray, fine-grained and compact.

(25) 01SFLC24

Location: 16° 57.7340'S, 173° 55.1598'E

Depth: 1,987m

Core Length: 0 cm

Sea Floor Photograph: The sea floor is covered by unconsolidated sediments with scattering white spots. A basalt cobbles, partly altered to reddish brown color is observed on the surface of unconsolidated sediments.

Sampling was conducted in the West Area to know distribution of ore showings. Fragments of black glass with 2mm thick Mn oxides on their surface were collected. Pyrite grains of sand-size collected together with black glass suggest existence of ore showing nearby the sampling site.

(26) 01SFLC25

Location: 16° 57.7239'S, 173° 55.0281'E

Depth: 1,979m

Core Length: 0 cm

Sea Floor Photograph: Brecciated basalt with thin coverage of unconsolidated sediments is observed

Sampling was conducted in the West Area to know distribution of ore showings. Small fragments of black glass were collected.

(27) 01SFLC26

Location: 16° 57.8933'S, 173° 55.9548'E

Depth: 1,993m

Core Length: 25 cm

Sea Floor Photograph: Basalt boulders of 10-50cm across are scattered over unconsolidated sediments.

Sampling was conducted in the West Area to know distribution of ore showings. Soft mudstones covered by 5mm thick Mn oxides were collected. This suggests an existence of ore showing nearby the sampling site.

3-3-3-2 Results of LC and MC sampling

The results of LC and MC sampling are summarized below

The unconsolidated sediments were collected at the sites (01SFLC09, LC15, LC26) over the gentle hill in the western part of the Axial Valley and on the flat top of the Western Ridge (LC12). These are brown clay and they, occasionally, include fragments of Mn oxides and thin layers consisting of Mn oxides and volcanic glass. The thickness of the unconsolidated sediments at the top of gentle hill varies from 0.75 to 1m and it is more or less 1m on the top of the Western Ridge. Other than the above locations, basaltic lavas are exposed partly covered by thin sediments of about 10cm thick.

Fragments of basalt were collected at the many location together with fragments of black glass and some of basalt fragments have black glass on their surface. The surface of the Axial Valley seems to be occupied by glassy surface basalt flows.

The Mn-oxides layers of few mm thick, covering over the surface of unconsolidated sediments, basalt and black glass, were, occasionally, found in the collected samples. Since the Mn-oxides is considered to be the precipitates by hydrothermal activity, the occurrence of this suggests an existence of ore showing nearby..

3-3-4 Drilling Survey

The drilling survey by BMS was conducted at 22 sites (11 sites in the West

Area, 11 sites in the East Area). Since five drill holes had been drilled in the North Fiji Basin in 1999, drill hole number of this year starts from BMS06. Location of the drilling sites of the Triple Junction Area is given in Figures 3-3-2, and West Area in Figure 3-3-2-2 and East Area in Figure 3-3-2-3, respectively. The results of the drilling survey is shown in Table 3-3-4-1, and photographs of drill core, columnar chart of the drill core, photographs of drill site and photographs of typical samples were given in Appendices 4 to 7.

Description of the drill core is given below.

3-3-4-1 West Area

(1) 01SFBMS06

Location: $16^{\circ} 57.5776'S$, $173^{\circ} 55.0896'E$, Ore Showing W7

Depth: 1,984m

Drilling Length: 990cm

Core Length: 334cm (7 core barrels)

Core Recovery: 34%

Drill Site: Size of the mound is unknown, because BMS directly landed on the mound. Fragments of chimney, about 50cm across, and reddish brown mud are distributed on the surface and sheets of massive sulfide ore are partly exposed. A bundle of three chimneys, each of which 2m high and 50cm across, is observed on the mound. The drill site is at edge of the mound 5m inside of the mound and approximately 2m high from the surrounding sea bottom.

Core Barrel 1 (Drilling Depth: 0-18cm, Core Length: 5cm): Three basalt fragments of 1-3cm across were collected and are discolored to reddish brown color.

Core Barrel 2 (Drilling Depth: 18-84cm, Core Length: 17cm): Dark gray, fine-grained, aphyric basalt with few vesicles. The core is crushed to 1-5cm size fragments. Minute grains of pyrite are rarely observed along fracture of 1mm wide.

Core Barrel 3 (Drilling Depth: 83-301cm, Core Length: 38cm): Blackish gray, fine-grained, compact basalt. Many fractures at interval of 2-3cm occur along the core and the core is partly crashed to 2-3cm size fragments. Veins of 5mm wide consisting of fragments of basalt, silica minerals, glass and pyrite grains occur in basalt. Pyrite is, also, found in thin fractures.

Core Barrel 4 (Drilling Depth: 301-522cm, Core Length: 55cm): Pale greenish gray, altered hyaloclastite with pebble size basalt fragments. The size of basalt fragments varies from 1cm to 5cm and large fragments are dark gray and small ones

Table 3-3-4-1 Results of Drilling Survey 1/2

West Area

No.	Hole No.	Ore Showing	Location		depth (m)	Core- barrel	interval (cm)		drilling length (cm)	Core length (cm)	Core- recovery (%)	Sample description (cm)
			latitude	longitude			start	end				
1	01SFBMS06	W7	16°57.5776' S	173°55.0896' E	1.984	1	0	18	18	5	28	oxide fragments of basalt (5)
						2	18	84	66	17	26	basalt (17)
						3	84	301	217	38	18	basalt (38) Fissure is filled with pyrite
						4	301	522	221	55	25	hyaloclastite (55)
						5	522	656	134	14	10	hyaloclastite (14)
						6	656	859	203	74	36	hyaloclastite (74)
						7	859	990	131	131	100	hyaloclastite (131)
						Total			990	334	34	
2	01SFBMS07	W8	16°57.6071' S	173°55.0912' E	1.979	1	0	137	137	15	11	fragments of basalt(15)
						2	137	170	33	33	100	fragments of black glass and basalt(33)
						3	170	310	140	59	42	fragments of black glass and basalt (59)
						Total			310	107	35	
3	01SFBMS08	W3	16°57.5659' S	173°55.0810' E	1.980	1	0	165	165	96	58	massive sulfide (96)
						2	165	384	219	26	12	massive sulfide (26)
						3	384	596	212	50	21	massive sulfide (50)
						4	596	748	152	52	34	massive sulfide (10) . hyaloclastite (42)
						Total			748	224	30	
4	01SFBMS09	W4	16°57.5708' S	173°55.0863' E	1.979	1	0	60	60	58	97	clay and fragments of basalt (28) . basalt (30)
						2	60	137	77	76	99	basalt (76)
						Total			137	134	98	
5	01SFBMS10	W6	16°57.5890' S	173°55.0486' E	1.976	1	0	116	116	18	16	oxide fragments of basalt (5) . massive sulfide (13)
						2	116	331	215	77	36	massive sulfide (40) . hyaloclastite (37)
						3	331	546	215	90	42	hyaloclastite (90)
						Total			546	185	34	
6	01SFBMS11	W5	16°57.5611' S	173°54.9651' E	1.983	1	0	219	219	69	32	mud(64) . fragments of black glass(5)
						2	219	437	218	26	12	black glass and fragments of basalt(26)
						3	437	567	130	56	43	basalt (56)
						Total			567	151	27	
7	01SFBMS12	W1	16°57.3258' S	173°55.0742' E	1.975	1	0	215	215	49	23	massive sulfide (49)
						2	215	344	129	69	53	hyaloclastite(69)
						3	344	558	214	37	17	basalt (37)
						Total			558	155	28	
8	01SFBMS24	W3	16°57.5470' S	173°55.0816' E	1.980	1	0	132	132	55	42	massive sulfide (55)
						2	132	160	28	28	100	massive sulfide (28)
						3	160	380	220	28	13	massive sulfide (28)
						4	380	596	216	15	7	massive sulfide (15)
						5	596	762	166	20	12	massive sulfide (20)
						6	762	981	219	59	27	massive sulfide (20) . hyaloclastite (39)
						Total			981	205	21	
9	01SFBMS25	W6	16°57.6024' S	173°55.0651' E	1.981	1	0	31	31	25	81	clay(25)
						2	31	95	64	55	86	hyaloclastite (30) . basalt (25)
						Total			95	80	84	
10	01SFBMS26	W6	16°57.5866' S	173°55.0569' E	1.981	1	0	56	56	40	71	massive sulfide (25) . basalt (15)
						2	56	85	29	25	86	basalt (25)
						3	85	153	68	35	51	basalt (20) . hyaloclastite(15)
						Total			153	100	65	
11	01SFBMS27	W4	16°57.5361' S	173°55.0911' E	1.981	1	0	59	59	45	76	mud and fragments of basalt(10) . hyaloclastite(35)
						2	59	151	92	15	16	hyaloclastite (15)
						3	151	308	157	0	0	
						4	308	451	143	82	57	hyaloclastite (82)
						5	451	538	87	80	92	hyaloclastite (80)
						Total			538	222	41	

Table 3-3-4-1 Results of Drilling Survey 2/2

East Area

No.	Hole No.	Ore Showing	Location		depth (m)	Core-barrel	interval(cm)		drilling length (cm)	Core-length (cm)	Core-recovery (%)	Sample description (cm)
			latitude	longitude			start	end				
1	01SFBMS13	E3	16°57.5186' S	173°55.3911' E	1.994	1	0	187	187	49	26	clay and cobbles(49)
						2	187	247	60	35	58	basalt (35)
						Total			247	84	34	
2	01SFBMS14	E1	16°57.4998' S	173°55.3379' E	1.995	1	0	163	163	54	33	hyaloclastite(35).oxidized hyaloclastite(19)
						2	163	274	111	69	62	oxidized hyaloclastite (69)
						3	274	436	162	96	59	oxidized hyaloclastite (96)
Total			436	219	50							
3	01SFBMS15	E8	16°57.6679' S	173°55.2798' E	1.993	1	0	87	87	24	28	basalt (24)
						2	87	106	19	18	95	basalt (18)
						3	106	139	33	33	100	basalt (33)
Total			139	75	54							
4	01SFBMS16	E8	16°57.6772' S	173°55.2817' E	1.994	1	0	147	147	24	16	fragments of basalt and mud(24)
						2	147	272	125	50	40	basalt (50)
						3	272	466	194	28	14	fragments of baalt(28)
Total			466	102	22							
5	01SFBMS17	E13	16°57.7318' S	173°55.4080' E	1.987	1	0	161	161	26	16	massive sulfide (26)
						2	161	161	0	6	-	fragments of massive sulfide(6)
						Total			161	26	16	
6	01SFBMS18	E11	16°57.6779' S	173°55.4356' E	1.991	1	0	86	86	50	58	basalt (50)
						2	86	301	215	15	7	basalt (15)
						3	301	491	190	77	41	hyaloclastite (77)
4	491	526	35	35	100	hyaloclastite (35)						
Total			526	177	34							
7	01SFBMS19	Eastern Ridge	16°57.5824' S	173°55.4869' E	1.973	1	0	84	84	16	19	mud (10) , basalt (6)
						2	84	162	78	45	58	basalt (45)
						3	162	377	215	10	5	basalt (10)
Total			377	71	19							
8	01SFBMS20	E4	16°57.5723' S	173°55.4099' E	1.988	1	0	80	80	24	30	massive sulfide (24)
						2	80	145	65	14	22	basalt (14)
						3	145	162	17	12	71	basalt (12)
4	162	170	8	8	100	basalt (8)						
Total			170	58	34							
9	01SFBMS21	E4	16°57.6245' S	173°55.3797' E	1.990	1	0	73	73	11	15	reddish clay (6) , basalt(5)
						2	73	116	43	39	91	basalt (39)
						3	116	231	115	24	21	basalt (24)
4	231	289	58	.	.	Core barrel was lost.						
Total			231	74	32							
10	01SFBMS22	E12	16°57.7418' S	173°55.4598' E	1.983	1	0	59	59	20	34	reddish clay (6) , basalt (14)
						2	59	142	83	75	90	basalt (75)
						Total			142	95	67	
11	01SFBMS23	E12	16°57.7196' S	173°55.4704' E	1.982	1	0	89	89	41	46	massive sulfide (10) , basalt (31)
						2	89	120	31	29	94	basalt (29)
						3	120	138	18	13	72	basalt (13)
						4	138	165	27	27	100	basalt (27)
						5	165	214	49	49	100	basalt (49)
Total			214	159	74							

are altered to pale gray. The matrix consists of few mm size fragments of basalt, silica minerals and pale greenish gray clay. It is weakly disseminated by pyrite.

Core Barrel 5 (Drilling Depth: 522-656cm, Core Length: 14cm): Same hyaloclastite as Core Barrel 4. Core is disturbed and consists of angular basalt fragments of 2-3cm across and pale greenish gray clay. Unaltered basalt fragments are blackish gray, fine-grained, compact and aphyric

Core Barrel 6 (Drilling Depth: 656-859cm, Core Length: 74cm): Altered hyaloclastite. Upper half of the core, 0-35cm, is disturbed as same as Core Barrel 5, and consists of angular basalt fragments of 3-5cm across and pale greenish gray clay. Between 35-74cm altered hyaloclastite consisting of basalt fragments of 1-3cm across and matrix. The matrix is composed of pale gray clay and basalt fragments of few mm size and is weakly disseminated by pyrite.

Core Barrel 7 (Drilling Depth: 859-990cm, Core Length: 131cm): Altered hyaloclastite consisting of basalt fragments of 1-3cm across and matrix of fine basalt fragments, silica minerals and pale greenish gray clay. Weakly disseminated by pyrite. The color of basalt fragments varies from blackish gray to pale gray depending on degree of alteration.

The hole was drilled at the edge of mound in Ore Showing W7. Discolored basalt of reddish brown occurs on surface, and relatively fresh basalt continues to 3m deep. The occurrences of pyrite bearing fractures and 5mm wide vein with pyrite suggest that the basalt belongs to the stock work zone of the mineralization. The basalt was underlain by hyaloclastite of smectite-chlorite alteration.

(2) 01SFBMS07

Location: 16° 57.6071'S, 173° 55.0912'E, Ore Showing W8

Depth: 1,979m

Drilling Length: 310cm

Core Length: 107cm (3 core barrels)

Core Recovery: 35%

Drill Site: Drilling site is close to mound and is occupied by sediments with white spots and basalt cobbles of 10cm across.

Core Barrel 1 (Drilling Depth: 0-137cm, Core Length: 15cm): Dark brown clay with basalt pebbles of 0.5-4cm across. Basalt is blackish, fine-grained, compact and glassy.

Core Barrel 2 (Drilling Depth: 137-170cm, Core Length: 33cm): Upper 10cm consists of angular fragments of black glass and basalt, 0.5-3cm across. Blackish gray, fine-grained, compact, glassy basalt occupies between 10-33cm. It is crushed to fragments of 5-8cm across and chlorite and epidote occur on the surface of fragments and along crack of 1mm wide.

Core Barrel 3 (Drilling Depth: 170-310cm, Core Length: 59cm): Upper 30cm consists of angular fragments of black glass and basalt, 1-5cm across and they, possibly, are collapsed fragments from upper horizon. Black glass occurs on the surface of some of the basalt fragments. The same basalt as Core Barrel 3 occurs between 30-59cm. Chlorite and epidote are found on the surface of basalt fragments.

The hole was drilled at the site near Ore Showing W8 where the sea floor is covered by unconsolidated sediments with basalt pebble. Basalt with black glass on its surface occurs covered by dark brown clay of 1.3m thick. It is uncertain whether appearance of chlorite and epidote is related to the mineralization of Ore Showing W8.

(3) 01SFBMS08

Location: 16° 57.5659'S, 173° 55.0810'E, Ore Showing W3

Depth: 1,980m

Drilling Length: 748cm

Core Length: 224cm (4 core barrels)

Core Recovery: 30%

Drill Site: The drill site is located at 50m inside of the mound from the edge. The mound with a gentle slope is upraised more than 5m from surrounding sea floor and reddish brown debris consisting of chimney and massive sulfide, 0.1-3.0m across, is distributed over the mound. Few reddish brown chimneys of 1-3m high are observed on the mound. Sheets of massive sulfide are, occasionally, exposed covered by reddish brown mud with white patches similar to bacteria mat. At the drill site fragments of sulfide ore are distributed over reddish brown mud.

Core Barrel 1 (Drilling Depth: 0-165cm, Core Length: 95cm): Massive sulfide ore, aggregation of fine chalcopyrite, pyrite and bornite grains, is collected from 0 to 95cm. The core is partly crushed to fragments of 2-5cm across.

Core Barrel 2 (Drilling Depth: 165-384cm, Core Length: 26cm): Massive sulfide ore consisting of fine calcopyrite and pyrite grains. The core is crushed to 2-5cm size fragments. Some of dark colored fragments are included and they consist of pyrite

-chalcopyrite patches and dark matrix of bornite and sphalerite.

Core Barrel 3 (Drilling Depth: 384-596cm, Core Length: 50cm): Massive sulfide ore consisting of fine calcopyrite and pyrite grains. Pyrite of coarse grain size, few mm across, is observed occasionally surrounding small druse and some of the fragments show framboidal texture.

Core Barrel 4 (Drilling Depth: 596-748cm, Core Length: 52cm): Fragments of massive sulfide, 0-10cm across, occupy between 0-10cm and they, possibly, are collapsed fragments from upper horizon. Altered hyaloclastite was collected from 10-52cm. It consists of altered basalt pebble of 1-4cm across and matrix of gray clay, and it is disseminated by pyrite and chalcopyrite.

The hole is drilled on the mound of Ore Showing W3, more than 5m high from surrounding sea floor. Massive sulfide, consisting mainly of chalcopyrite and pyrite, occupies from the surface to 6m deep and it is underlain by altered hyaloclastite with smectite and chlorite alteration.

(4) 01SFBMS09

Location: 16° 57.5708'S, 173° 55.0863'E, Ore Showing W4

Depth: 1,979m

Drilling Length: 137cm

Core Length: 134cm (2 core barrels)

Core Recovery: 98%

Drill Site: The drill site is located about 10m away from the mound of Ore Showing W4. The mound is 5m high and 50 across, and several chimneys of 3m high were observed on top it. Basalt with thin coverage of reddish brown oxidized mud is distributed at the drill site.

Core Barrel 1 (Drilling Depth: 0-60cm, Core Length: 58cm): From surface to 28cm, it is occupied by gray clay with 2-5mm size basaltic pebbles. Black, glassy basalt pebbles are partly replaced by silica minerals and the clay is weakly disseminated by pyrite. Beneath this, from 28cm to 58cm, blackish gray, fine-grained, compact, aphyric basalt occurs. It has pyrite disseminated veins of 2.5cm wide.

Core Barrel 2 (Drilling Depth: 60-137cm, Core Length: 78cm): Blackish gray, fine-grained, compact, aphyric basalt. Many 2-5mm wide fissures with pyrite are observed in basalt.

The hole is drilled at 10m away from the mound of Ore Showing W4. The basalt with pyrite veinlet at this site belongs to stockwork zone of the mineralization.

(5) 01SFBMS10

Location: 16° 57.5890'S, 173° 55.0486'E, Ore Showing W6

Depth: 1,976m

Drilling Length: 546cm

Core Length: 185cm (3 core barrels)

Core Recovery: 34%

Drill Site: The drill site is located at the edge, about 5m inside of the mound (Ore Showing W4) and is about 2m high from the surrounding sea floor. The mound of the Ore Showing W4 is 5m high and 50m across. Debris consisting of reddish brown fragments of chimney and sulfide ore is distributed over the mound. Fragments of sulfide ore, few tens of cm across, scattered over mud of orange color at the drill site.

Core Barrel 1 (Drilling Depth: 0-116cm, Core Length: 18cm): From the surface to 5cm, altered basalt fragments of 2-3cm across were collected. Beneath this, from 5-18cm, it is massive sulfide consisting of fine grains of pyrite and calcopyrite and is crushed to fragments of 1-4cm across.

Core Barrel 2 (Drilling Depth: 116-331cm, Core Length: 77cm): Massive sulfide continues from 0 to 42cm. It consists of pyrite-calcopyrite rich patches of 1-5cm across and dark matrix surrounding the patches. Sphalerite and bornite in addition to pyrite and calcopyrite are observed in the matrix. The massive sulfide is underlain by altered hyaloclastite (42-77cm). The hyaloclastite consists of basalt fragments of 1-3cm across and dark gray matrix. The basalt fragments show different degree of alteration depending on their size. Relatively large fragments are fresh with dark gray color and small fragments are altered to pale gray. The matrix consists of dark gray clay, basalt fragments and silica minerals and it is weakly disseminated by pyrite and chalcopyrite.

Core Barrel 3 (Drilling Depth: 331-546cm, Core Length: 90cm): Hyaloclastite as same as Core Barrel 2. The basalt fragments are 1-3 cm across and weakly pyrite and calcopyrite disseminated matrix consists of dark gray clay, basalt fragments and silica minerals.

The drill hole is located at the edge of the Ore Showing W6 mound. More than 1m thick massive sulfide with thin cover of oxidized basalt, occurs at the drill site. The

massive sulfide shows two stage of formation; the first stage is formation of pyrite-chalcopyrite patch and the second stage is formation of the dark matrix with sphalerite. Altered hyaloclastite with smectite and a dissemination of pyrite and chalcopyrite constitutes the footwall

(6) 01SFBMS11

Location: 16° 57.5611'S, 173° 54.9651'E, Ore Showing W5

Depth: 1,983m

Drilling Length: 567cm

Core Length: 151cm (3 core barrels)

Core Recovery: 27%

Drill Site: The drilling is conducted at approximately 30m away from the mound of Ore showing W5 where basalt pebble scattered over the sediments.

Core Barrel 1 (Drilling Depth: 0-219cm, Core Length: 69cm): Brown clay. Layers of sand-size glass grains and fragments of black glass, 1-3cm across, are occasionally included.

Core Barrel 2 (Drilling Depth: 219-437cm, Core Length: 25cm): Fragments of basalt and black glass, 1-5cm across. Basalt is blackish gray and compact. Black glass is observed on the surface of some of the basalt fragments.

Core Barrel 3 (Drilling Depth: 437-567cm, Core Length: 56cm): Black, compact and aphyric basalt. Rarely fine phenocrysts of plagioclase and olivine are observed. Pyrite occurs in veinlet.

The drilling was conducted at 30m away from Ore Showing W11. Relatively fresh basalt occurs under unconsolidated sediments of approximately 2m thick

(7) 01SFBMS12

Location: 16° 57.3258, 173° 55.0742'E, Ore Showing W1

Depth: 1,975m

Drilling Length: 558cm

Core Length: 155cm (3 core barrels)

Core Recovery: 28%

Drill Site: The drill site is located about 10m inside of the mound with a gentle slop and is 2m high from the surrounding sea floor. Fragments of chimney and sulfide ore of 0.1-1m across are scattered over reddish

brown oxidized sediments in the drill site. According to the results of FDC observation in 1999, a mound of 10m high with an extension of 100m exists in this drill site (Ore Showing W1, 2-1).

Core Barrel 1 (Drilling Depth: 0-215cm, Core Length: 45cm): Slightly porous massive sulfide consisting of fine calcopyrite and pyrite grains. The core is crushed to fragments of 5cm across.

Core Barrel 2 (Drilling Depth: 215-344cm, Core Length: 69cm): Strongly altered hyaloclastite. The core is disturbed and it consists of dark bluish gray to dark gray clay and few mm across fragments of black glass.

Core Barrel 3 (Drilling Depth: 344-558cm, Core Length: 37cm): Blackish gray, fine grained, compact, aphyric basalt. Fracture occurs at about 5cm interval and the core is crushed along the fractures. It is weakly disseminated by pyrite.

The drill site is located at the edge of relatively large mound extending over the area of 100m (Ore Showing W1). The massive sulfide occurs from the surface to 2m deep and it is underlain by 1m thick altered hyaloclastite with smectite alteration. Basalt with fractures occurs underneath hyaloclastite.

(8) 01SFBMS24

Location: 16° 57.5470, 173° 55.0816'E, Ore Showing W3

Depth: 1,980m

Drilling Length: 981cm

Core Length: 205cm (6 core barrels)

Core Recovery: 21%

Drill Site: The drill site is located at 30m inside of the mound of Ore Showing W3 and is 5m high from the surrounding sea floor. At the drill site, fragments of sulfide ore, 0.1-3m across, are distributed over reddish brown mud with bacteria mat.

Core Barrel 1 (Drilling Depth: 0-132cm, Core Length: 55cm): Massive sulfide with calcopyrite, pyrite and sphalerite. It consists of pyrite-calcopyrite rich patches surrounded by a black matrix rich in sphalerite and oxides. The core is fractured to fragments of 3-5cm across.

Core Barrel 2 (Drilling Depth: 132-160cm, Core Length: 28cm): Massive sulfide, as same as Core Barrel 1.

Core Barrel 3 (Drilling Depth: 160-380cm, Core Length: 28cm): Massive sulfide, as same as Core Barrel 1.

Core Barrel 4 (Drilling Depth: 380-596cm, Core Length: 15cm): Massive sulfide, as same as Core Barrel 1. The core is crushed to fragments of 1-3cm across.

Core Barrel 5 (Drilling Depth: 596-762cm, Core Length: 15cm): Crushed fragments of sulfide ore. Core is mostly crushed to coarse sand to pebble size fragments and the detail is not known. Partly remained pebble size fragments consist of pyrite-chalcopyrite spots of 1mm across and dark gray siliceous matrix.

Core Barrel 6 (Drilling Depth: 596-762cm, Core Length: 15cm): Crushed massive sulfide fragments as same as Core Barrel 5 occurs from 0 to 20cm. It probably is collapsed material from upper horizon. Altered, pale bluish gray hyaloclastite occurs from 20 to 59cm. It consists of altered pale grayish gray fragments of volcanic rocks and clay matrix, and it is disseminated by pyrite.

The drill site is located on the mound (Ore Showing W3) with more than 30cm extension. The massive sulfide with calcopyrite, pyrite and sphalerite occurs from the surface to 7m deep and it is underlain by altered hyaloclastite with smectite alteration.

(9) 01SFBMS25

Location: 16° 57.6024'S, 173° 55.0816'E, Ore Showing W6

Depth: 1,981m

Drilling Length: 95cm

Core Length: 80cm (2 core barrels)

Core Recovery: 84%

Drill Site: The drill site is located on the boundary between the mound of 10m high (Ore Showing W6) and surrounding sea floor. Fragments of chimney and sulfide ore, 0.5-2m across, are scattered over reddish brown sediments in the area. The drilling was conducted just on the boundary between reddish brown, oxidized sediments and unaltered brown sediments

Core Barrel 1 (Drilling Depth: 0-31cm, Core Length: 25cm): Dark greenish gray clay. Minute grains of pyrite are rarely observed in lower part.

Core Barrel 2 (Drilling Depth: 31-95cm, Core Length: 55cm): From 0-30cm, it is relatively fresh hyaloclastite consisting of angular black glass fragments of 1-2cm across and vitric matrix. Pyrite and calcopyrite are, rarely, found in fissures and vesicles. Beneath this, blackish gray, fine-grained, compact and aphyric basalt occur from 30-55cm.

The drill hole was conducted at contact between the mound of Ore Showing W6 and the surrounding sea floor. No clear sign of mineralization and alteration in the collected core samples suggests that the mineralization and alteration of the Ore Showing W6 do not extend outside of the mound. Relatively fresh hyaloclastite and basalt occur covered by unconsolidated sediments of 30cm thick.

(10) 01SFBMS26

Location: 16° 57.5866'S, 173° 55.0569'E, Ore Showing W6

Depth: 1,981m

Drilling Length: 153cm

Core Length: 100cm (2 core barrels)

Core Recovery: 65%

Drill Site: The drill site is located at the edge of the mound (Ore Showing W6).

Reddish brown, sulfide ore fragments of 1m across are distributed over reddish brown sediments at the drill site.

Core Barrel 1 (Drilling Depth: 0-56cm, Core Length: 40cm): Slightly porous massive sulfide ore consisting of fine pyrite and calcopyrite grains occur from the surface to 25cm. Beneath this, 25-40cm, blackish gray, glassy, compact basalt occurs. It is soft because of weathering.

Core Barrel 2 (Drilling Depth: 56-85cm, Core Length: 25cm): Blackish gray, glassy, compact basalt with weak pyrite dissemination. The core is crushed and disturbed to pebble size fragments and clay.

Core Barrel 3 (Drilling Depth: 85-153cm, Core Length: 35cm): From the surface to 20cm, the basalt as same as Core Barrel 2 occurs and black glass is found on surface of some of the fragments. From 20 to 35cm it is hyaloclastite consisting of black glass fragments and vitric matrix. The core is crushed to fragments of few cm across.

The drilling was conducted at the edge of the mound (Ore Showing W6). Massive sulfide occurs from the surface to 25cm and it is underlain by basalt and hyaloclastite. Clear sign of mineralization and alteration are found in basalt and hyaloclastite in spite of their occurrence close to massive sulfide.

(11) 01SFBMS27

Location: 16° 57.5361'S, 173° 55.0911'E, Ore Showing W4

Depth: 1,981m

Drilling Length: 538cm

Core Length: 222cm (5 core barrels)

Core Recovery: 41%

Drill Site: The drill site is located at the edge of large mound (Ore Showing W4).

Reddish brown, sulfide ore fragments of 20cm across are distributed over reddish brown sediments at the drill site.

Core Barrel 1 (Drilling Depth: 0-59cm, Core Length: 45cm): Reddish brown clay with basalt fragments of less than 1cm occurs from the surface to 10cm. From 10-45cm, it is altered hyaloclastite consisting of altered, pale bluish gray basalt fragments of 5-10mm across and blackish gray vitric matrix. Pyrite occurs in fissures and vesicles.

Core Barrel 2 (Drilling Depth: 59-115cm, Core Length: 15cm): Altered hyaloclastite as same as Core Barrel 1, consisting of altered basalt fragments and blackish gray clay.

Core Barrel 3 (Drilling Depth: 115-308cm, Core Length: 0cm): Core was not obtained. Sulfide particles were observed in drilling dust during the drilling operation of Core Barrel 3.

Core Barrel 4 (Drilling Depth: 308-451cm, Core Length: 82cm): Altered hyaloclastite. It consists of blackish gray compact basalt fragments of 0.2-2cm across and matrix of fine basalt fragments and gray clay. The smaller basalt fragments are altered to gray color and the matrix is weakly disseminated to pyrite.

Core Barrel 5 (Drilling Depth: 451-538cm, Core Length: 80cm): Altered hyaloclastite similar to Core Barrel 4. It consists of angular basalt fragments of 0.3-6cm across and matrix of basalt fragments, more or less 1mm across, and gray clay. The larger basalt fragments are blackish gray, fine-grained, compact, aphyric and smaller ones are altered showing reddish brown to gray color. It is weakly disseminated by pyrite.

The drill site is located at the edge of mound (Ore Showing W4). Massive sulfide ore was not collected, however, the hyaloclastite with smectite alteration, constituting footwall, exists at least from the surface to 5m deep at this drill site.

3-4-2-2 East Area

(1) 01SFBMS13

Location: 16° 57.5186'S, 173° 55.3911'E, Ore Showing E3

Depth: 1,994m

Drilling Length: 247cm

Core Length: 84cm (2 core barrels)

Core Recovery: 34%

Drill Site: The drill site is close to mound (E3) and cobbles of basalt are scattered over sediments partly discolored to reddish brown with white spots. The mound of approximately 10m high was observed nearby but the details are not known.

Core Barrel 1 (Drilling Depth: 0-187cm, Core Length: 49cm): Oxidized reddish brown clay with fragments of black glass, few mm across, occur from the surface to 5cm. Beneath this, dark greenish gray clay with basalt fragments of 1-4cm across.

Core Barrel 2 (Drilling Depth: 187-247cm, Core Length: 35cm): Blackish gray, fine-grained, compact, aphyric basalt. The core is crushed to fragments of 1-5cm across.

The drill site is located close to the mound of Ore Showing E3 and is overlain by sediments with basalt cobbles. Relatively fresh basalt occurs covered by sediments of approximately 2m thick.

(2) 01SFBMS14

Location: 16° 57.4998'S, 173° 55.3379'E, Ore Showing E1

Depth: 1,995m

Drilling Length: 436cm

Core Length: 219cm (3 core barrels)

Core Recovery: 50%

Drill Site: The size of the mound is unknown, because BMS directly landed on the mound (Ore Showing E1). The drilling was conducted beside a chimney of 5m high. Reddish brown sediments with fragments of sulfide ore, 10cm across, are distributed at the drill site. The mound of 10m high and 100m across (Ore Showing 4-2) has been found at this site by FDC in 1999.

Core Barrel 1 (Drilling Depth: 0-163cm, Core Length: 54cm): Altered hyaloclastite. From 0 to 35cm, it is dark gray hyaloclastite with sub-angular basalt fragments of 0.5-3cm across. Most of the basalt fragments are altered showing gray color and few fragments remain unaltered with blackish gray color. Matrix of the hyaloclastite consists of 1-2mm size, altered basalt fragments and gray clay, and it is disseminated by pyrite. Beneath this, from 35 to 45cm, the same hyaloclastite is oxidized showing reddish brown color. The core is crushed to fragments of few cm across.

Core Barrel 2 (Drilling Depth: 163-274cm, Core Length: 69cm): Oxidized,

reddish brown hyaloclastite. It has 0.5-5cm size, basalt fragments of different color. Oxidized fragments show reddish brown and relatively fresh ones blackish brown. The matrix consists of basalt fragments of few mm across and reddish brown clay, and is weakly disseminated by pyrite. The core is mostly crushed to fragments of 10cm across.

Core Barrel 3 (Drilling Depth: 274-436cm, Core Length: 96cm): Oxidized, reddish brown hyaloclastite as same as Core Barrel 2.

A fragment of massive sulfide, 11cm across, was accidentally collected attached to the BMS body. It is presumably a fragment of chimney at this drill site. The sample consists of fine pyrite, sphalerite and calcopyrite grains and shows a banded structure of varying mineral compositions.

The drill hole is located on the mound of Ore Showing E1, close to an occurrence of chimney. Only altered hyaloclastite was collected, however, the sulfide particles in drilling dust during drilling operation of Core Barrel 2 suggest an existence of massive sulfide at the site.

(3) 01SFBMS15

Location: 16° 57.6679'S, 173° 55.2798'E, Ore Showing E8

Depth: 1,993m

Drilling Length: 139cm

Core Length: 75cm (3 core barrels)

Core Recovery: 54%

Drill Site: The drill site is located close to the mound (Ore Showing E8), at 3m east of the edge. The size of the mound is 5m high and 40m across.

Core Barrel 1 (Drilling Depth: 0-87m, Core Length: 24cm): Pebble size fragments of basalt and black glass. The size of the fragments is 1-3cm across and some of basalt fragments have black glass on their surface. Basalt is blackish gray, compact and aphyric.

Core Barrel 2 (Drilling Depth: 87-106cm, Core Length: 18cm): Blackish gray, compact, aphyric basalt. The core consists of 3cm size basalt fragments, some of which have black glass on their surface.

Core Barrel 3 (Drilling Depth: 106-139cm, Core Length: 33cm): Basalt as same as Core Barrel 2. The core consists of 1-3cm size basalt fragments.

Although drill site is close to the mound of Ore Showing E8, no clear alteration and mineralization were found in the basalt.

(4) 01SFBMS16

Location: 16° 57.6672'S, 173° 55.2817'E, Ore Showing E8

Depth: 1,994m

Drilling Length: 466cm

Core Length: 102cm (3 core barrels)

Core Recovery: 22%

Drill Site: The drill site is located close to the mound (Ore Showing E8), at 5m west of the edge. Basalt cobbles and boulders of 10-50cm across are distributed over sediments. Discoloring of the sediments is not observed at drill site.

Core Barrel 1 (Drilling Depth: 0-147cm, Core Length: 24cm): Clay with basalt pebbles. Upper horizon of the clay, from the surface to 10cm, is oxidized to reddish brown color and beneath this it shows dark gray color. Sub-angular pebbles of basalt are 1-4cm across and they are blackish gray, vesicular and aphyric.

Core Barrel 2 (Drilling Depth: 147-272cm, Core Length: 50cm): Blackish gray, compact, aphyric basalt. Fissures of 1mm wide occur at about 5cm interval and chlorite and pyrite are found in some of the fissures.

Core Barrel 3 (Drilling Depth: 272-466cm, Core Length: 28cm): From 0 to 5cm, fragments of black glass, 3-4cm across, were collected. They are possibly fragments collapsed from upper horizon. From 5 to 28cm, it is the basalt as same as Core Barrel 2.

Although drill site is very close to the mound of Ore Showing E8, basalt without clear alteration and mineralization were collected beneath 1.5m thick unconsolidated sediments.

(5) 01SFBMS17

Location: 16° 57.7438'S, 173° 55.4080'E, Ore Showing E13

Depth: 1,987m

Drilling Length: 161cm

Core Length: 26cm (2 core barrels)

Core Recovery: 16%

Drill Site: The drill site is located on the mound of Ore Showing E13, approximately 30m inside of the mound from the edge and close to a chimney of 5m high. Fragments of sulfide ore, 50cm across, are distributed over reddish brown sediments at the drill site.

Core Barrel 1 (Drilling Depth: 0-161cm, Core Length: 20cm): From 0 to 20cm, massive sulfide ore is collected. Few cm size patches of irregular shape, consisting of calcopyrite and pyrite, occur in black matrix of pyrite, chalcopyrite and sphalerite. From 20 to 25cm, dark gray clay and 1cm size fragments of basalt and sulfide ore occur.

Core Barrel 2 (Drilling Depth: 161-161cm, Core Length: 6cm): 1-2cm size fragments of crashed sulfide ore.

Although the drilling was conducted on the mound of Ore Showing E13, only fragments of chimney on the surface of the mound were collected by Core Barrels 1 and 2.

(6) 01SFBMS18

Location: 16° 57.6779'S, 173° 55.4356'E, Ore Showing E11

Depth: 1,991m

Drilling Length: 526cm

Core Length: 177cm (4 core barrels)

Core Recovery: 34%

Drill Site: The BMS directly landed on the mound of Ore Showing E11 and drilling was conducted at the site. According to the results of FDC in 1999, the mound extends over an area of 150m, uprising 10m from the surrounding sea floor. Reddish brown bedrock is exposed at the drill site.

Core Barrel 1 (Drilling Depth: 0-86cm, Core Length: 50cm): Blackish gray, vesicular, aphyric basalt. Between 35 to 50cm, fracture occurs at an interval of 3cm.

Core Barrel 2 (Drilling Depth: 86-301cm, Core Length: 15cm): The same basalt as Core Barrel 1. The core consists of fragments of 3-5 cm across, because of fracturing.

Core Barrel 3 (Drilling Depth: 301-491cm, Core Length: 77cm): Gray, altered hyaloclastite. It consists of angular basalt fragments, 1-5cm across, and matrix of gray clay with fine basalt fragments. The basalt fragments are blackish gray, fine-grained, compact, and the smaller fragments showing pale gray color are altered to clay. It is disseminated by pyrite.

Core Barrel 4 (Drilling Depth: 491-526cm, Core Length: 77cm): Gray, altered hyaloclastite as same as Core Barrel 3.

The drilling was conducted on the mound of Ore Showing E11. The sulfide particles in drilling dust appeared during the drilling operation of lower half of Core

Barrel 1 to Core Barrel 2. This suggests an occurrence of massive sulfide ore between the basalt and altered hyaloclastite. Deeper than 3m, altered hyaloclastite with smectite alteration occurs.

(7) 01SFBMS19

Location: 16° 57.5824'S, 173° 55.4869'E

Depth: 1,973m

Drilling Length: 377cm

Core Length: 71cm (3 core barrels)

Core Recovery: 19%

Drill Site: The drilling site is located on a small pillow lava hill on the eastern slope of the axial valley. Pillow lava occurs covered by thin sediments at the drill site. Reddish brown spots of oxidation are found on the sediments.

Core Barrel 1 (Drilling Depth: 0-84cm, Core Length: 16cm): Clay is collected from the surface to 10cm. The clay of upper half is oxidized to reddish brown color and lower half shows dark greenish gray. Beneath this, gray, slightly silicified basalt fragments of 2-3cm across occur. They are slightly disseminated by pyrite

Core Barrel 2 (Drilling Depth: 84-162cm, Core Length: 45cm): Blackish gray, fine-grained, slightly vesicular basalt. The core is crushed to fragments of 3-5cm across.

Core Barrel 3 (Drilling Depth: 162-377cm, Core Length: 10cm): The same basalt as Core Barrel 2. The core is crushed to fragments of 3-5cm across.

The drilling was conducted on a pillow lava hill and no clear sign of mineralization and alteration was found in basalt.

(8) 01SFBMS20

Location: 16° 57.5723'S, 173° 55.4099'E, Ore Showing E4

Depth: 1,988m

Drilling Length: 170cm

Core Length: 58cm (4 core barrels)

Core Recovery: 34%

Drill Site: The Drilling site is located on the mound of Ore Showing E4. Fragments of chimney and sulfide ore, 1m across, are distributed on the reddish brown sediments at the drill site. According to the results of FDC in 1999, the mound extends over an area of 100m, uprising

5m from the surrounding sea floor

Core Barrel 1 (Drilling Depth: 0-80cm, Core Length: 24cm): Massive sulfide ore with fragments of basalt. Black porous massive sulfide consisting of calcopyrite, pyrite sphalerite occurs between 8 to 15cm, surrounded by basalt fragments of 1-3cm across. Basalt is blackish gray, vesicular and some of the fragments have 1cm wide quartz vein with pyrite and chlorite.

Core Barrel 2 (Drilling Depth: 80-145cm, Core Length: 14cm): Basalt fragments of 1-5cm across. Basalt is blackish gray, fine-grained and compact. Basalt fragments, such as black glass on its surface, disseminated by pyrite, with quartz vein of 5mm across, are observed.

Core Barrel 3 (Drilling Depth: 145-162cm, Core Length: 12cm): The same basalt as Core Barrel 2. The core is crushed to fragments of 1-5cm across and pyrite occurs on the surface and in vesicles.

Core Barrel 4 (Drilling Depth: 162-170cm, Core Length: 8cm): The same basalt as Core Barrel 2. The core is crushed to fragments of 1-5cm across and thin pyrite-chalcopyrite films are attached on some of the fragments.

Two fragments of massive sulfide ore, 20cm across, were accidentally collected attached to the BMS body. They are presumably fragments of chimney at this drill site. The samples consist of fine pyrite, sphalerite and calcopyrite grains. From the shape of the samples, they seem to be part of vent of chimney, and have chalcopyrite rich zone on the inner side of the fragments.

The drilling was conducted on the mound of Ore showing E3. Sulfide particles in the drilling dust observed all through the drilling operation of Core Barrel 1 suggest an occurrence of massive sulfide from the surface to 80cm deep. The occurrences of quartz veins with pyrite in the basalt fragments suggest that the basalt belongs to stock work zone

(9) 01SFBMS21

Location: 16° 57.6245'S, 173° 55.3797'E, Ore Showing E4

Depth: 1,990m

Drilling Length: 231cm

Core Length: 74cm (4 core barrels)

Core Recovery: 32%

Drill Site: The Drilling site is located close to the southern edge of the mound (Ore Showing E4) and is covered by reddish brown sediments.

Core Barrel 1 (Drilling Depth: 0-73cm, Core Length: 11cm): Reddish brown clay was collected from 0-6cm, however, the thickness of the clay is considered to be 30cm from drilling operation. Beneath this, basalt fragments of 3cm across were collected. The basalt is blackish gray, fine-grained and vesicular. Surface and fissures of the basalt fragments were oxidized to reddish brown color. Sulfide particles in drilling dust were observed during the drilling operation.

Core Barrel 2 (Drilling Depth: 73-116cm, Core Length: 39cm): Blackish gray, fine-grained, vesicular basalt. The core is crushed to 1-7cm size fragments. Discoloring to pale yellowish green on the surface of the fragments and oxidation suggest that it is fractured basalt.

Core Barrel 3 (Drilling Depth: 116-231cm, Core Length: 24cm): Fragments of sulfide ore, 1cm across, possibly collapsed material from upper horizon, occur at the top. They consist of pyrite and calcopyrite. Beneath this, it is the same fractured basalt as Core Barrel 2 and the core is crushed to 1-4cm size fragments.

Core Barrel 4 (Drilling Depth: 231-289cm, Core Length: 0cm): The core barrel was lost.

The drilling was conducted close to the mound of Ore Showing E4. Fractured basalt covered by 30cm thick sediments occur at the site. Sulfide particle in drilling dust and the fragments of sulfide ore suggest an occurrence of massive sulfide at shallow horizon.

(10) 01SFBMS22

Location: 16° 57.7418'S, 173° 55.4598'E, Ore Showing E12

Depth: 1,983m

Drilling Length: 142cm

Core Length: 95cm (2 core barrels)

Core Recovery: 67%

Drill Site: The Drilling site is located on the mound where fragments of sulfide ore are distributed over reddish brown sediments.

Core Barrel 1 (Drilling Depth: 0-59cm, Core Length: 20cm): Reddish brown clay was collected from 0 to 6cm. Beneath this, blackish gray, fine-grained, aphyric, vesicular basalt occurs. The size of vesicles is 1mm across.

Core Barrel 2 (Drilling Depth: 59-142cm, Core Length: 75cm): The basalt same as Core Barrel 1. Vertical fractures occur along core Reddish brown oxidized zone of 1mm thick and minute grains of pyrite are observed along the fracture.

Although drilling was conducted on the mound of Ore Showing E12, only relatively fresh basalt was sampled.

(11) 01SFBMS23

Location: 16° 57.7196'S, 173° 55.4704'E, Ore Showing E12

Depth: 1,982m

Drilling Length: 214cm

Core Length: 159cm (5 core barrels)

Core Recovery: 74%

Drill Site: The drilling is conducted at 50m northeast of 01SFBMS22 and the site is located at the edge of the mound, 1m high from the surrounding sea bottom. Fragments of sulfide ore, 0.2-1m across, are distributed over reddish brown sediments at the drill site..

Core Barrel 1 (Drilling Depth: 0-89cm, Core Length: 41cm): Porous massive sulfide consisting of fine pyrite, calcopyrite, sphalerite occurs from 0-to 10cm. From 10 to 41cm, it is blackish gray, fine-grained, aphyric, vesicular basalt. Large vesicles, some of which reaches 1cm in diameter, characterize the basalt. Occurrences of pyrite veins, 5mm across, and coverage of pyrite on the surface of basalt fragments suggest that the basalt belongs to stockwork zone.

Core Barrel 2 (Drilling Depth: 89-120cm, Core Length: 29cm): Black, fine-grained, aphyric basalt with large vesicles. Some of the vesicles are as large as 1cm in diameter and quartz-pyrite veins occur filling fractures of few mm across.

Core Barrel 3 (Drilling Depth: 120-138cm, Core Length: 13cm): The same basalt as Core Barrel 2. The core is crushed to fragments of 2-3cm across. Pyrite occurs on the surface and in vesicles.

Core Barrel 4 (Drilling Depth: 138-165cm, Core Length: 27cm): The same basalt as Core Barrel 2. The core is crushed to fragments of few cm across and weakly disseminated by pyrite.

Core Barrel 5 (Drilling Depth: 165-214cm, Core Length: 49cm): The same basalt as Core Barrel 2. Pyrite occurs filling fractures.

The drilling site is located at the edge of the mound (Ore Showing E12), approximately 1m high from the surrounding sea floor. Massive sulfide occurs from the surface to 10cm underlain by the basalt with pyrite veins of stockwork zone. The stockwork zone continues about 80cm and it becomes to the basalt with weak pyrite

dissemination.

3-3-4-3 Results of the Drilling Survey

The Results of the drilling survey are summarized in Table 3-3-4-2 and Figure 3-3-4-1.

Unconsolidated sediments, basalt, massive sulfide and hyaloclastite were collected by the drilling conducted on and around the hydrothermal mound of the ore showings.

The basalt samples are, generally, fresh without strong alteration and mineralization. However, some of them have veins with sulfide, more or less 5mm across. These are considered to be the basalt of the stockwork zone. The fresh hyaloclastite is rarely observed and it is strongly altered at most of the cases. The altered hyaloclastite commonly occurs overlain by massive sulfide and it forms the alteration zone. The massive sulfide consisting mainly of pyrite, calcopyrite and sphalerite was collected in the Ore Showings W1, W3 and W6 of the West Area and in the Ore Showings E4, E12 and E13 of the East Area.

In the West Area, the massive sulfide was confirmed by two drill holes (01SFBMS08 and 01SFBMS24) in the Ore showing W3 for the lengths of, respectively, 5.96m and 7.62m. It is expected that the mound of the Ore Showing W3 have a thick massive sulfide. The massive sulfide was, also, confirmed in the Ore Showings W1 (01SFBMS12) and W6 (01SFBMS10 and 01SFBMS26), and expected length of the massive sulfide at each drill site, respectively, 2.15m, 1.36m and 0.25m, is short compared with those of the Ore Showing W3. These differences in the length of massive sulfide were clearly reflected by the location of the drilling site. The two drilling sites of the Ore Showing W3, where thick massive sulfide were confirmed, were located in the middle of the mound, rising 10m from the surround sea floor. Although the mound of the Ore Showing W1 rises 10m high, the drilling site of 01SFBMS12, where the length of massive sulfide being confirmed as 2.15m, is located at the edge of the mound, approximately 2m high from the surrounding sea floor. Further, two drill sites of the Ore Sowing W6 are located at the edge of the mound, respectively, 2m high for 01SFBMS10 and at the same level as the surrounding sea floor for 01SFBMS26. The above evidences suggest that the massive sulfide only occur in uplifted part of the mound, not reaching to the deeper horizon. All of the drill holes other than above 5 are located either at vicinity of or at edge of mound and no massive sulfide was collected. The massive sulfide does not seem to occur out side of the mound.

In the East Area, the massive sulfide was collected only from three drill holes,

Table 3-3-4-2 Summary of Drilling Survey 1/2

West Area

Ore Showing	Estimated Size of mound	Name of Hole	Drill Site	Sample Descriptions	Geological Unit
W1	Height:10m, Width:100m	01SFBMS12	on mound 10m from the margin	0-2.15m : massive sulfide 2.15-3.44m : altered hyaloclastite 3.44-5.58m : basalt	0-2.15m:massive sulfide 2.15-3.44m:alteration zone 3.44-5.58m:basalt
W3	Height:10m, Width:100m	01SFBMS08	on mound 50m from the margin	0-5.96m : massive sulfide 5.96-7.48m : altered hyaloclastite disseminated by Py and Cp	0-5.96m:massive sulfide 5.96-7.48m:alteration zone
		01SFBMS24	on mound 30m from the margin	0-7.62m : massive sulfide 7.62-9.81m : altered hyaloclastite	0-7.62m:massive sulfide 7.62-9.81m:alteration zone
W4	Height:10m, Width:100m	01SFBMS09	about 10m away form mound in WS direction	0-0.28m : clay with cobble of basalt 0.28-1.37m : stockwork zone	0-0.28m:unconsolidated sediment 0.28-1.37m:stockwork zone
		01SFBMS27	the NE margin of mound	0-0.10m : reddish clay 0.10-5.38m : altered hyaloclastite	0-0.10m:unconsolidated sediment 0.10-5.38m:alteration zone
W5	Height : unknown, Width : over 30m	01SFBMS11	about 30m away from the mound in west direction	0-2.19m : reddish clay 2.19-5.67m : not altered basalt	0-2.19m:unconsolidated sediment 2.19-5.67m:basalt
W6	Height:5m, Width:50m	01SFBMS10	sloop of mound, 5m inside of mound	0-0.2m : basalt 0.20-1.56m : massive sulfide 1.56-5.46m : altered hyaloclastite	0-0.20:basalt 0.20-1.56m:massive sulfide 1.56-5.46m:alteration zone
		01SFBMS25	on the boundary between the southern tip of mound and sediment	0-0.31m : clay 0.31-0.61m : not altered hyaloclastite 0.61-0.95m : not altered basalt	0-0.31m:unconsolidated sediment 0.31-0.61m:hyaloclastite 0.61-0.95:basalt
		01SFBMS26	at the margin of mound	0-0.25m : massive sulfide 0.25-1.38m : not altered basalt 1.38-1.53m : not altered hyaloclastite	0-0.25m:massive sulfide 0.25-1.38m:basalt 1.38-1.53m:hyaloclastite
W7	Height:5m, Width over 20m	01SFBMS06	on the mound 5m inside from the northern edge	0-3.01m : stockwork zone 3.01-9.90m : altered hyaloclastite	0-3.01m:stockworkzone 3.01-9.90m:alteration zone
W8	Height : unknown, Width : unknown	01SFBMS07	western vicinity of W8	0-1.37m : clay with pebbles of basalt 1.37-3.10m : not altered basalt	0-1.37m:unconsolidated sediment 1.37-3.10m:basalt

Table 3-3-4-2 Summary of Drilling Survey 2/2

East Area

Ore Showing	Estimated Size of mound	Name of Hole	Drill Site	Sample Descriptions	Geological Unit
E1	Height:10m, Width:100m	01SFBMS14	on the mound, near chimney of 5m high	Altered or oxidized hyaloclastite disseminated by pyrite. Sulfide dust were observed during drilling No.2 core barrel.	0-4.36m:alteration zone
E3	Height:10m, Width : unknown	01SFBMS13	at the vicinity of mound	0-1.87m:reddish sediment 1.87-2.47m:not altered basalt	0-1.87m:unconsolidated sediment 1.87-2.47m:basalt
E4	Height:5m, Width:100m	01SFBMS20	on the mound, near the northern end	0-0.80m:massive sulfide 0.80-1.70m:stockwork zone of basalt	0-0.80m:massive sulfide 0.80-1.70m:stockwork zone
		01SFBMS21	at the vicinity of southern edge of mound	0-0.30m:unconsolidated sediments 0.30-2.31m: basalt with fissure massive sulfide may be distributed from the surface to 70m deep.	0-0.30m:unconsolidated sediment massive sulfide ? 0.30-2.31m:basalt
E8	Height:10m, Width : over 30m	01SFBMS15	3m away from western edge of mound	non-altered basalt with black glass	0-1.39m:basalt
		01SFBMS16	5m away from the western edge of mound	0-1.47m:clay with pebbles of basalt 1.47-4.66m:not altered basalt	0-1.47m:unconsolidated sediment 1.47-4.66m:basalt
E11	Height:10m, Width:150m	01SFBMS18	on mound	0-3.01m:basalt 3.01-5.26m:altered hyaloclastite massive sulfide be distributed between depths 1 to 3m .	0-3.01m:basalt massive sulfide ? 1.31-5.26m:alteration zone
E12	Height : unknown, Width : over 20m	01SFBMS22	on mound	0-0.06m:unconsolidated sediment 0.06-1.42m:not altered basalt	0-0.06m:unconsolidated sediment 0.06-1.42m:basalt
		01SFBMS23	at the edge of mound	0-0.10m:massive sulfide 0.10-0.89m:basalt of stockwork zone 0.89-2.14m:non-altered basalt	0-0.10m:massive sulfide 0.10-0.89m:stockwork zone 0.89-2.14m:basalt
E13	Height:10m, Width:over30m	01SFBMS17	on the mound, 30m inside of mound	drilled massive sulfide fragment	fragment of massive sulfide,φ20cm
	upper part of basalt dome	01SFBMS19	on pillow lava covered by thin sediments.	0-0.10m:unconsolidated sediment 0.10-3.77m:not altered basalt	0-0.10m : unconsolidated sediment 0.10-3.77m:basalt

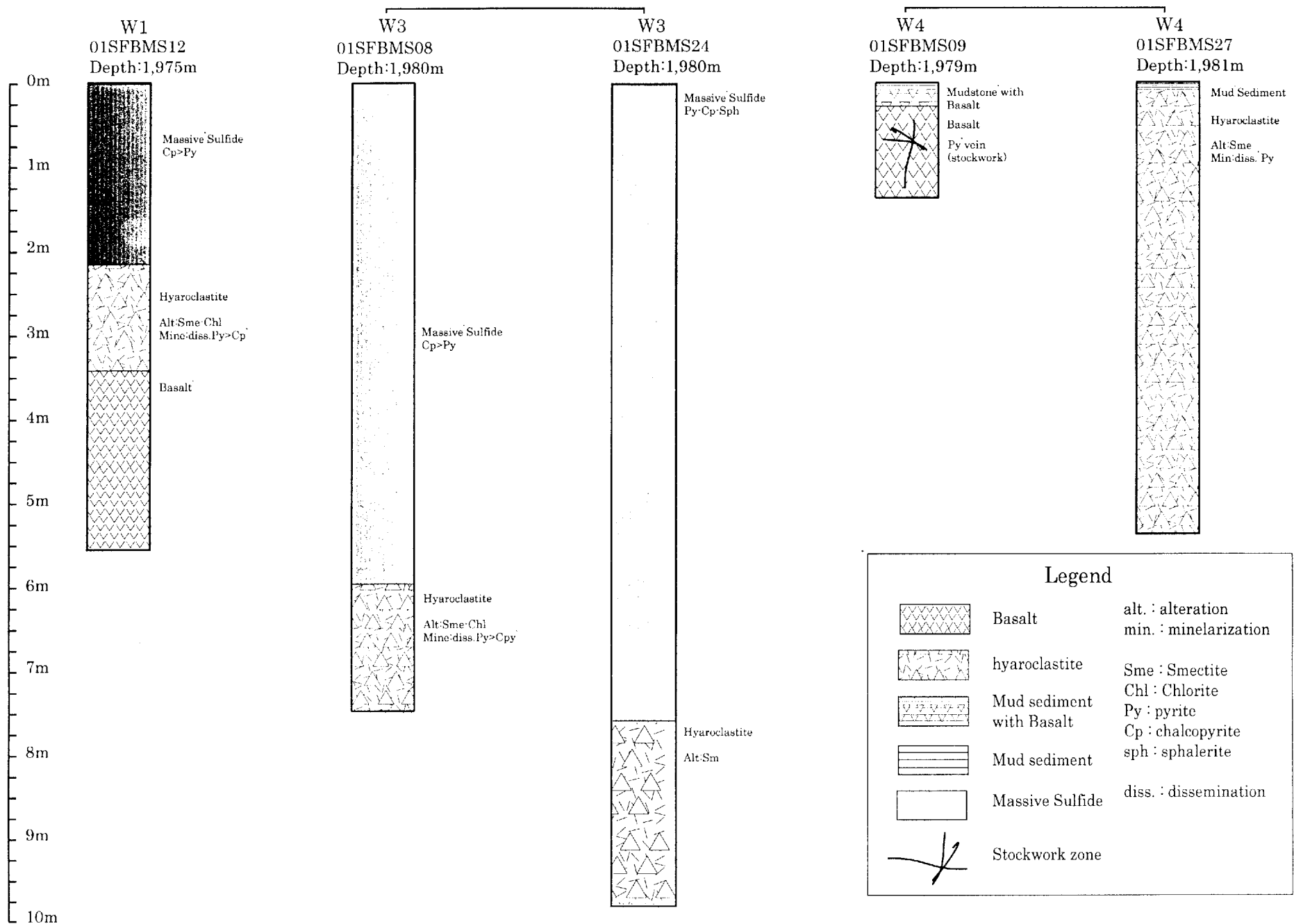


Figure 3-3-4-1 Results of Drilling Survey (West Area)1/6

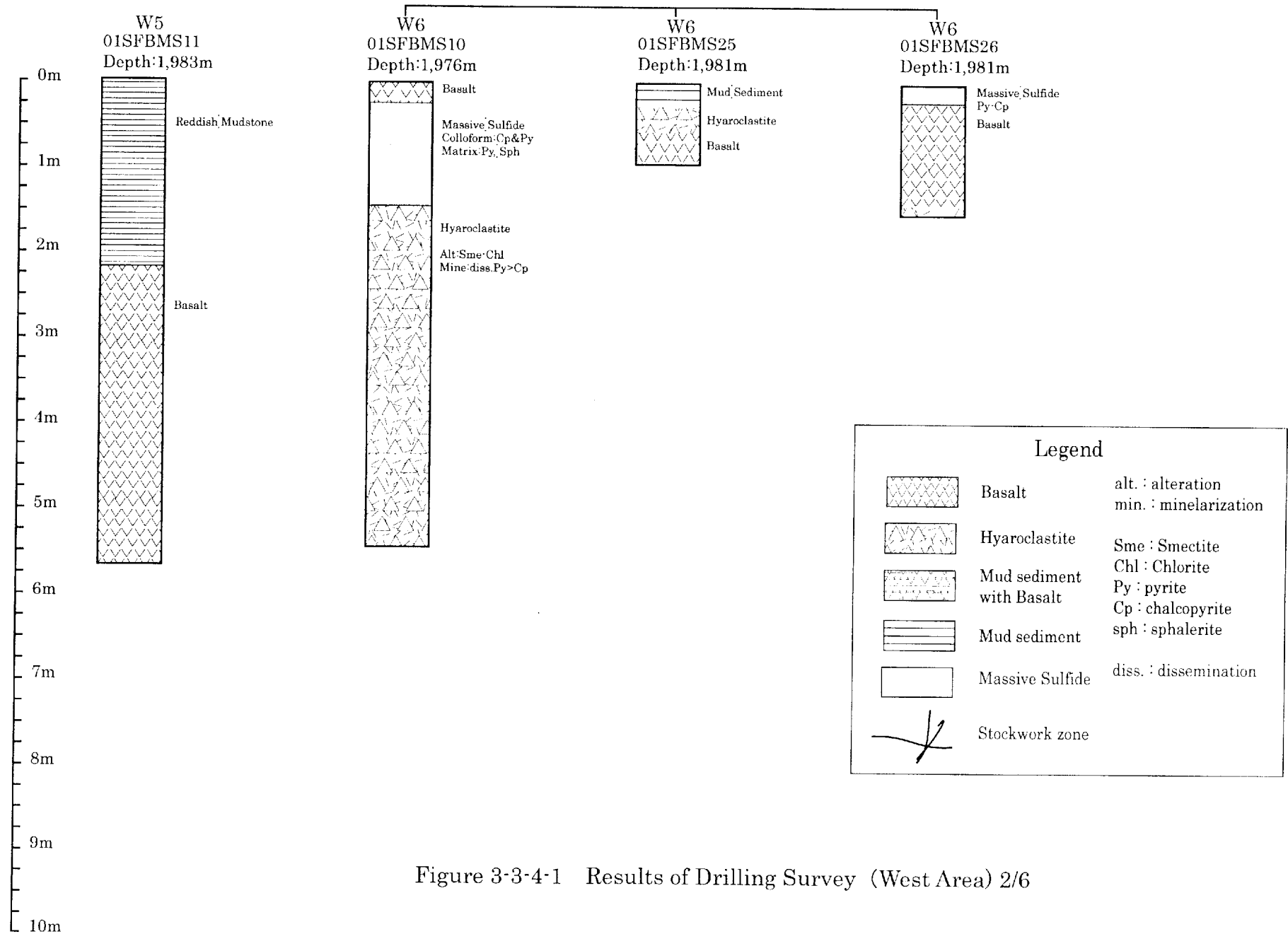


Figure 3-3-4-1 Results of Drilling Survey (West Area) 2/6

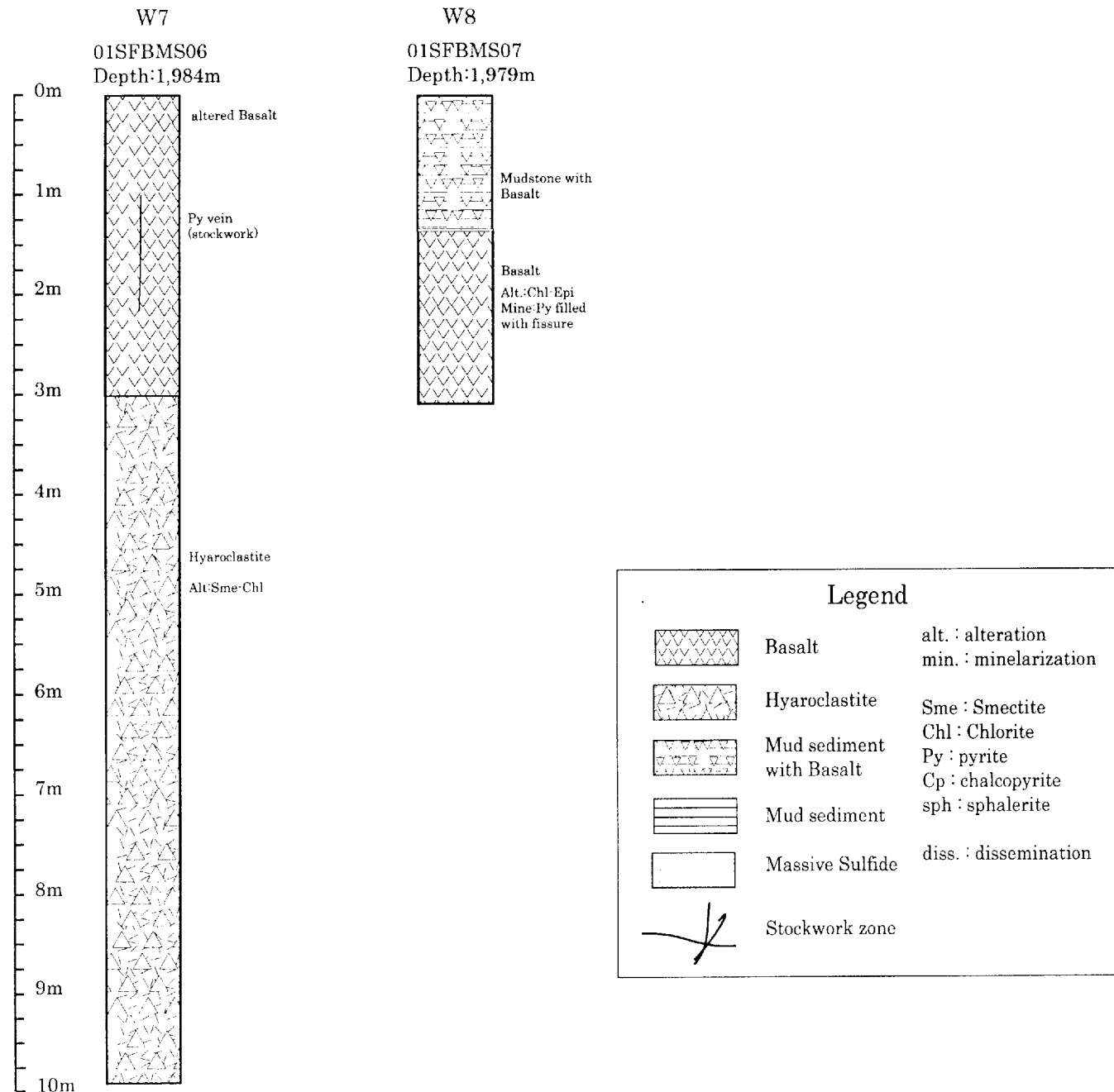


Figure 3-3-4-1 Results of Drilling Survey (West Area) 3/6

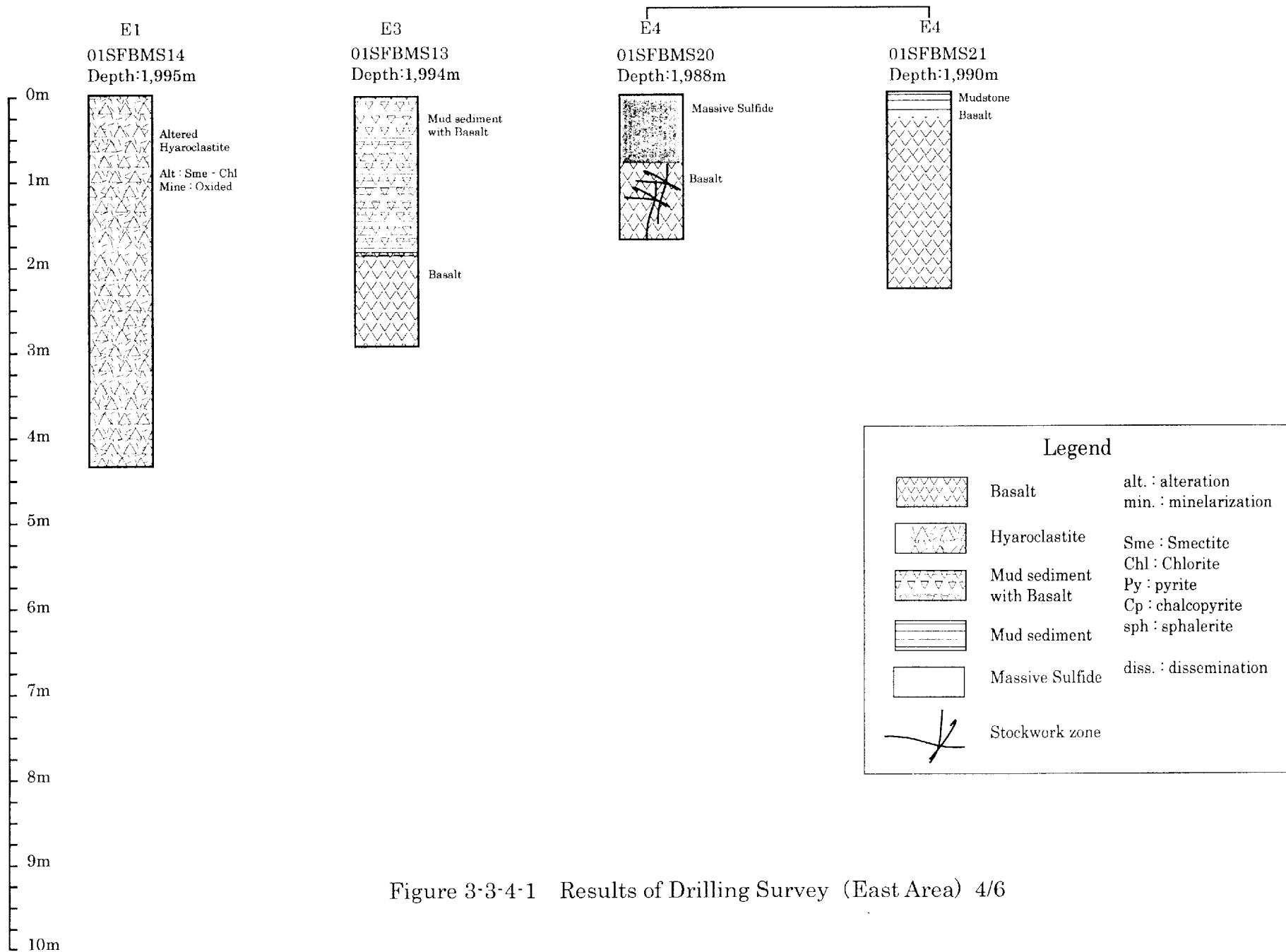


Figure 3-3-4-1 Results of Drilling Survey (East Area) 4/6

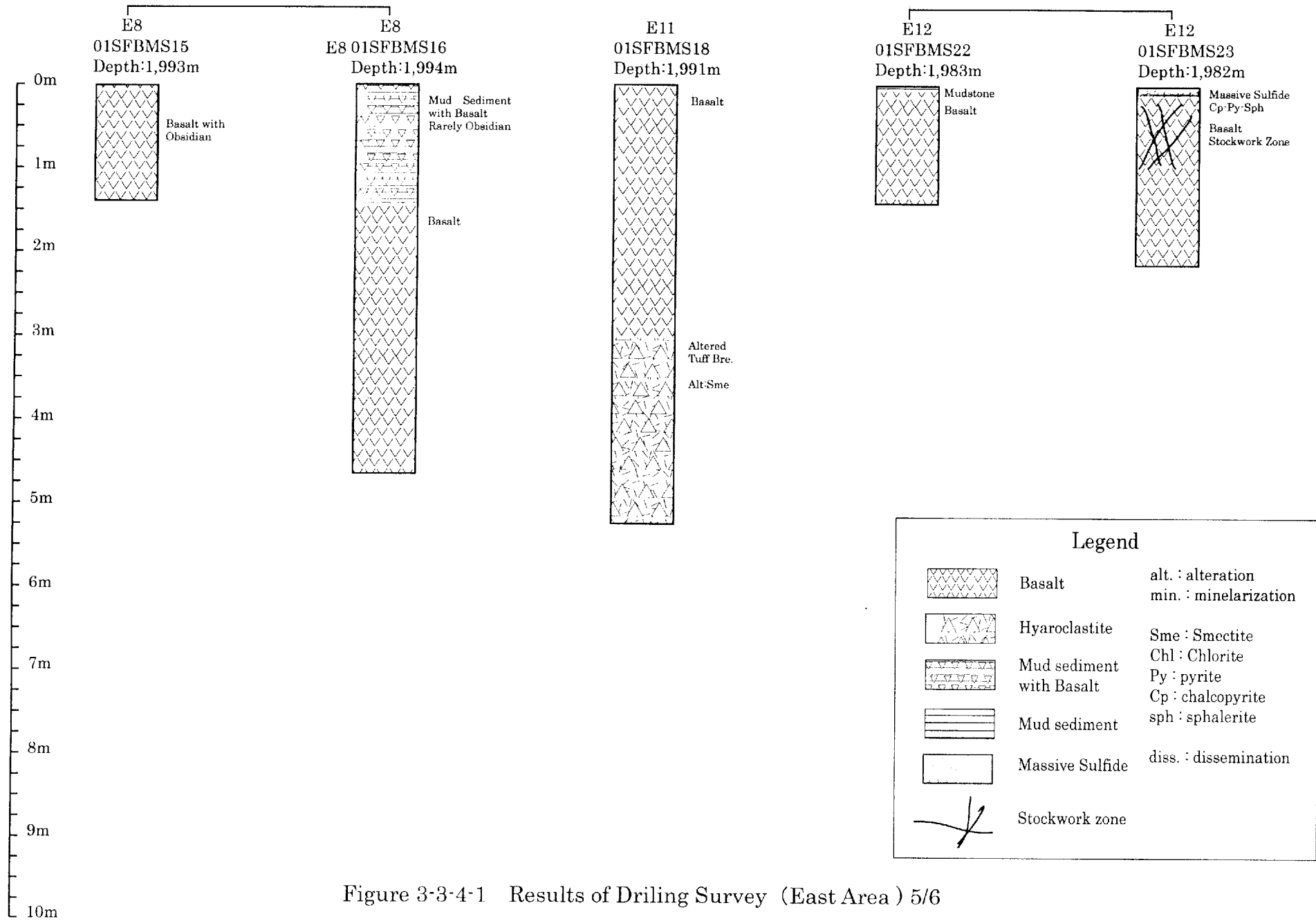


Figure 3-3-4-1 Results of Drilling Survey (East Area) 5/6

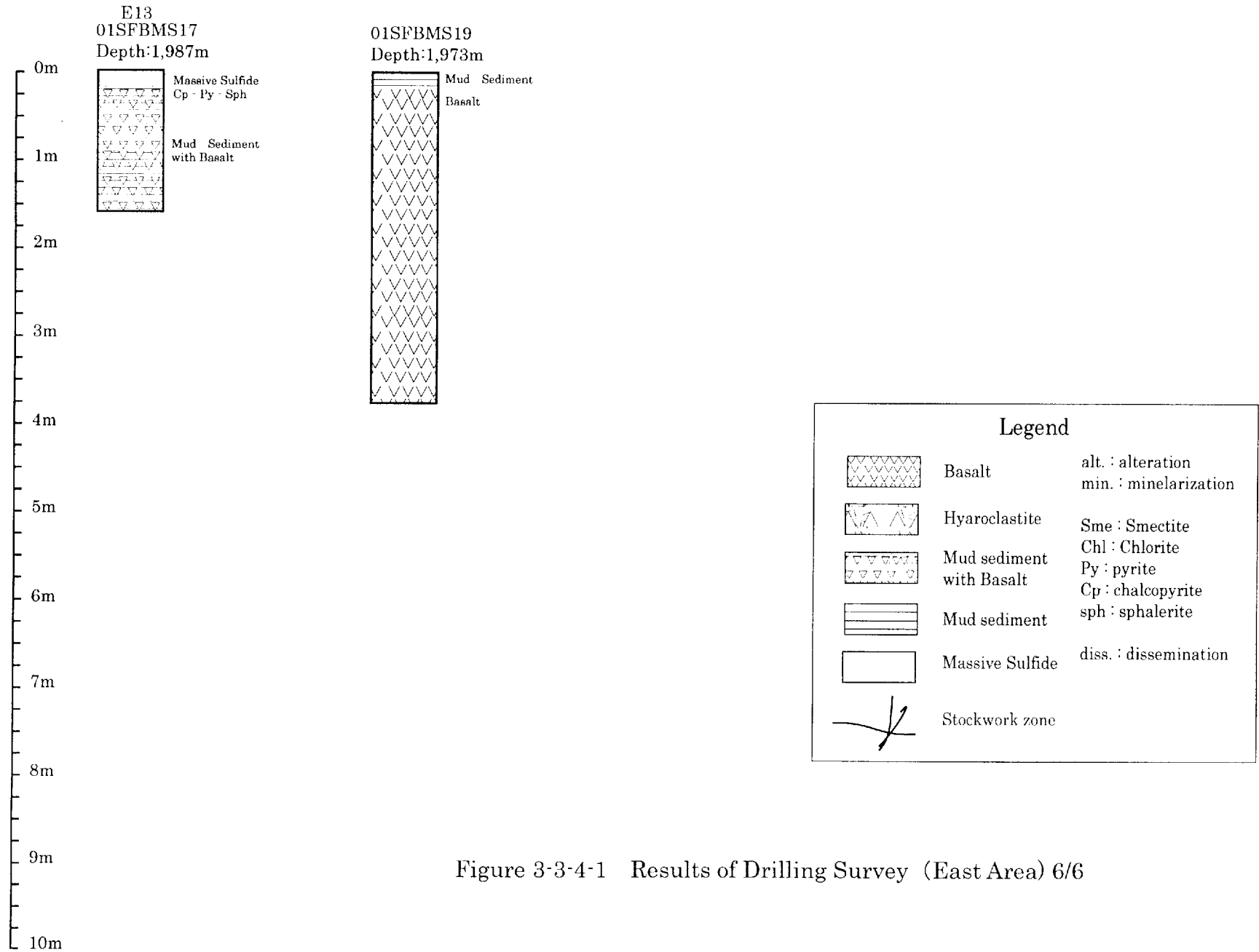


Figure 3-3-4-1 Results of Drilling Survey (East Area) 6/6

namely 01SFBS20 (Ore Showing E4), 01SFBS23 (Ore Showing E12) and 01SFBS17 (Ore Showing E13). The lengths of the massive sulfide at 01SFBS20 and 01SFBS17 are, respectively 80cm and 10cm, and a chimney relic was drilled at 01SFBS17. Compared to the West Area, thick massive sulfide was not collected in the East Area. This is partly due to the rough surface of the mound in the East Area, many of them being located on the slope. There were some cases that the flat space for BMS was not found on the certain mound, being forced to shift drill site at the vicinity of the mound. Other cases are that even though the drilling operation was conducted on mound at 01SFBS14 and 01SFBS18 with occurrences of sulfide particles in the drilling dust during the operation, no massive sulfide were collected probably because of lost core.

Except at 01SFBS10 where the massive sulfide is covered by 20cm thick basalt flow, the massive sulfide always occurs on the surface. Although there is one exceptional case exists at 01SFBS20 where basalt of the stockwork zone occurs directly beneath the massive sulfide, the massive sulfide is always underlain by altered hyaloclastite and it forms alteration zone of the footwall. It seems that the hydrothermal solution of the mineralization passed through the hyaloclastite with higher porosity rather than basalt. The occurrences of the altered hyaloclastite of the alteration zone and the basalt of the stockwork zone at the vicinity of the mound suggest that the alteration and mineralization extends laterally over area of the mound, and they characterize the margin of the mineralization.

The constituents of the hydrothermal mound were documented by the drilling. The massive sulfide occurs on the top of the mound and the thickness of it corresponds to the height of the mound rising from the surrounding sea floor. The massive sulfide is underlain by altered hyaloclastite which forms the alteration zone of the footwall. Although the massive sulfide is not found at the vicinity of the mound, alteration and stockwork zones occur as the marginal zone of the mineralization.

3-3-5 Characteristics of the Volcanic Rocks

For the understanding of the characteristic of the volcanic rocks in the Triple Junction Area, thin sections for microscopic observation were prepared for the basalt and hyaloclastite and chemical analyses were conducted for the basalt. The sample list of thin sections and chemical analyses is given in Table 3-3-5-1. Since they are drilling core samples, the type of the basalt flow was not identified for basalt samples.

Table 3-3-5-1 Sample List of Thin Section and Chemical Analysis

Area	Ore Showing	Hole No.	Core Barrel No. : position	Thin Section	Chemical Analysis	Type of Rock	Remarks
West Area	W1	01SBFMS12	No.3 : 15-30cm	TS01	CA01	Basalt	Below alteration zone, Compact, Aphyric
	W3	01SBFMS08	No.4 : 25-30cm	TS01		Altered hyaloclastite	Footwall alteration zone
	W4	01SBFMS09	No.2 : 25-35cm	TS01	CA01	Basalt	Stockwork zone of basalt, Black, Compact
		01SBFMS27	No.1 : 10-45cm	TS01		Altered hyaloclastite	weak altered
	W5	01SBFMS11	No.2 : 10-26cm	TS01	CA01	Basalt	Compact, Aphyric, includes black glass
	W6	01SBFMS10	No.2 : 60-70cm	TS01		Altered hyaloclastite	Footwall alteration zone, same sample as XD02
		01SBFMS25	No.2 : 10cm	TS01		Hyaloclastite	Black glass composed of conglomerate and matrix, Disseminated by Py
	W7	01SBFMS06	No.3 : 0-20cm	TS01	CA01	Basalt	Stockwork Zone within Basalt, Black, Compact, Aphyric
			No.3 : 23-26cm	TS02		Vein within Basalt	Vein composed of Py and Cp
			No.4 : 40-45cm	TS03		Altered hyaloclastite	Alteration zone
W8	01SBFMS07	No.2 : 10-33cm	TS01	CA01	Basalt	Basalt of near surface, includes black glass, Compact, Aphyric	
East Area	E4	01SBFMS21	No.2 : 10-20cm	TS01	CA01	Basalt	Basalt near surface, Compact, Aphyric
	E8	01SBFMS16	No.2 : 10-40cm	TS01	CA01	Basalt	Basalt near surface, Compact, Aphyric
	E11	01SBFMS18	No.1 : 0-30cm	TS01	CA01	Basalt	Basalt near surface, vesicular
	E12	01SBFMS22	No.2 : 35-50cm	TS01	CA01	Basalt	Basalt near surface, vesicular

3-3-5-1 The results of microscopic observation

A total of 15 thin sections were made for the typical samples of basalt and hyaloclastite. The results of the microscopic observation were summarized on Tables 3-3-5-2 to 3-3-5-4 and photographs of the typical samples are given in Appendix 8.

Five sample of the basalt collected from the West Area show quenched nature with a vitreous groundmass and crtpctcrystalline texture and they are pyroxene basalt or pyroxene-olivine basalt. Among five samples, one sample, 01SFBMS12TS01, is aphyric and all the rest of four samples are porphyritic with phenocrysts of plagioclase, orthopyroxene, clinopyroxene and olivine. Although samples were collected from the different geological units, such as basalts of the footwall beneath the massive sulfide, stockwork zone and the one occurring on the surface, no systematic differences of the basalt depending on the geological unit were observed.

All of the four samples of basalt collected from the East Area are aphyric and three samples, except 01SFBMS22TS01, have vitreous groundmass of quenched nature. The aphyric nature of these four samples compared with porphyritic nature of the West Area may due to the collection of the samples at near surface in the East Area. The three samples, other than 01SFBMS16TS01, have olivine in addition to pyroxene. The occurrence of groundmass olivine in the three samples of the East Area suggests a nature of alkali basalt.

Among five samples of the hyaloclastite collected in the West Area, four samples were collected from the alteration zone and one sample, 01SFBMS25TS01, is relatively fresh rock collected at near the surface. The hyaloclastite of the alteration zone mainly consists of smectite, silica minerals and barite. While, in the relatively fresh hyaloclastite, glass remains without replacement to smectite. 01SFBMS06TS02 was taken from the vein with pyrite in the basalt of stockwork zone. The gangue minerals of it are barite, smectite and silica minerals.

3-3-5-2 Chemical Composition of the Basalt

The chemical analyses of the nine basalts, five samples from the West Area and four samples from the East Area, were conducted to understand chemical nature of the basalt flow of the area. The analytical results are given in Table 3-3-5-5 and the analytical method with detection limits is given in Appendix 9.

The results of the microscopic observation suggest no significant alteration for all of the analyzed samples. While, the analytical results show that the two samples, 01SFBMS06CA01 and 01SFBMS16CA01, are slightly altered with relatively high LOI, respectively 5.63% and 4.36% and high $\text{Fe}_2\text{O}_3/\text{FeO}$ ratios. The all of the nine samples

Table 3-3-5-2 Results of Microscopic Observation of Thin Sections (West Area :Basaltic Rock)

Ore Showing	Sample No.	Location	Rock Name	Texture	Alteration	Phenocryst						Groundmass						Alteration			
						Pl	Opx	Cpx	Px	Ol	Op	Pl	Opx	Cpx	Px	Ol	Op	G	Ch	Sm	
W1	01SFBMS12TS01	footwall	Pyroxene Olivine Basalt	aph.inter	weak							◎				○	○	△	○	·	△
W4	01SFBMS09TS01	stockwork	Pyroxene Basalt	cry	weak	○						○				○		○	○		○
W5	01SFBMS11TS01	near surface	Pyroxene Basalt	cry	medium	◎			△									△	·	△	
W7	01SFBMS06TS01	stockwork	Pyroxene Basalt	sph	weak	○	○	○			·	△				△			◎		
W8	01SFBMS07TS01	near surface	Pyroxene Olivine Basalt	sph	weak	◎	○	○		○	△	△				△			○	△	△

Minerals

Pl : Plagioclase
 Opx : Orthopyroxene
 Cpx : Clinopyroxene
 Px : Pyroxene
 Ol : Olivine
 Op : Opaque
 G : Glass
 Ch : Chlorite
 Sm : Smectite

Texture

sph ; spherulitic
 cry ; cryptocrystalline
 aph ; aphyric
 inter ; intergranular

◎ ; abundant (>30)
 ○ ; common (10~30)
 △ ; rare (3~10)
 · ; trace (<3)

Table 3-3-5-3 Results of Microscopic Observation of Thin Sections (West Area : Pyroclastic)

Ore Showing	Sample No.	Location	Rock Name	Alteration	Rock Fragments			Fragment					Matrix			alteration				
					diameter	shape	rock type	Pl	Cpx	Op	G	Op	G	Ba	Sm	Si	Ch	Sm	Si	
W3	01SFBMS08TS01	Alteration zone	altered hyaloclastite	weak	<1.0mm	brecciate	basalt silicified rock			○		·	○						△	△
W4	01SFBMS27TS01	Alteration zone	hyaloclastite	weak				△	·		○	○	○	○			○			
W5	01SFBMS10TS01	Alteration zone	altered hyaloclastite	weak	<1.0mm	brecciate	altered rock					△				△				
W6	01SFBMS25TS01	around seafloor	hyaloclastite	weak				△	△	·	◎						○			
W7	01SFBMS06TS02	within basalt	vein within basalt	weak	<0.5mm	brecciate	fragment of ore, basalt			○			○	△			·		·	
	01SFBMS06TS03	Alteration zone	altered hyaloclastite	weak	<0.7mm	brecciate	fragment of ore			△			○		△	△			△	△

Pl ; plagioclase
 Cpx ; Clinopyroxene
 Op ; Opaque
 G ; Glass
 Ba ; Barite
 Ch ; Chlorite
 Sm ; Smectite
 Si ;Silica

◎ ; abundant (>30%)
 ○ ; common (10~30%)
 △ ; poor (3~10%)
 · ; rare (<3%)

Table 3-3-5-4 Results of Microscopic Observation of Thin Sections (East Area :Basaltic Rock)

Ore Showing	Sample No.	Location	Rock Name	Texture	Alteration	Phenocryst						Groundmass						Alteration			
						Pl	Opx	Cpx	Px	Ol	Op	Pl	Opx	Cpx	Px	Ol	Op	G	Ch	Sm	
E4	01SFBMS21TS01	near surface	Olivine Pyroxene Basalt	aph	weak							○	○			○		○	△	△	
E8	01SFBMS16TS01	near surface	Pyroxene Basalt	aph	weak							◎		○			·	◎		○	
E11	01SFBMS18TS01	near surface	Pyroxene Olivine Basalt	aph	weak							○	○			○		○	△	△	
E12	01SFBMS22TS01	near surface	Olivine Pyroxene Basalt	aph,inter	weak							◎	○			○		·	·	△	△

Minerals

Pl ; Plagioclase
 Opx ; Orthopyroxene
 Cpx ; Clinopyroxene
 Px ; Pyroxene
 Ol ; Olivine
 Op ; Opaque
 G ; Glass
 Ch ; Chlorite
 Sm ; Smectite

Texture

sph ; spherulite
 cry ; cryptocrystalline
 aph ; aphyric
 inter ; intergranular

◎ ; abundant (>30)
 ○ ; common (10~30)
 △ ; rare (3~10)
 · ; trace (<3)

Table 3-3-5-5 Results of Chemical Analysis of Basaltic Rocks

Area	West Area					East Area			
Ore	W1	W4	W5	W7	W8	E4	E8	E11	E12
Hole No.	01SFBMS12	01SFBMS09	01SFBMS11	01SFBMS06	01SFBMS07	01SFBMS21	01SFBMS16	01SFBMS18	01SFBMS22
Sample No.	CA01	CA01	CA01	CA01	CA01	CA01	CA01	CA01	CA01
Location	footwall	stockwork	surface	stockwork	surface	surface	surface	surface	surface
SiO ₂ %	49.78	49.72	50.53	49.72	51.09	50.90	49.16	49.66	48.96
TiO ₂ %	1.17	1.20	1.56	1.50	1.55	1.73	2.83	2.25	1.88
Al ₂ O ₃ %	14.60	14.40	14.54	14.14	14.74	14.91	15.95	16.76	17.49
Fe ₂ O ₃ %	2.14	1.67	1.98	2.91	<0.01	2.27	2.22	2.07	2.89
FeO %	7.00	6.73	8.43	6.49	10.73	7.66	5.88	5.74	5.44
MnO %	0.17	0.16	0.18	0.13	0.17	0.17	0.15	0.13	0.13
MgO %	7.89	7.81	7.22	6.49	6.92	6.71	5.75	7.14	8.39
CaO %	11.82	11.56	11.21	9.77	11.30	11.25	9.52	10.59	10.35
Na ₂ O %	2.76	2.81	2.91	2.78	2.90	3.04	3.20	3.36	2.95
K ₂ O %	<0.01	0.05	0.30	0.17	0.32	0.53	0.87	1.01	0.88
P ₂ O ₅ %	0.10	0.10	0.15	0.15	0.16	0.23	0.51	0.43	0.34
CO ₂ %	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
H ₂ O ⁺ %	0.79	0.92	0.72	1.29	0.70	0.70	1.55	0.95	0.58
H ₂ O %	1.52	1.49	0.35	3.95	0.39	0.02	2.30	0.29	0.23
LOI %	2.86	2.90	1.41	5.66	1.57	0.68	4.36	1.14	0.70
TOTAL %	100.29	99.12	100.43	99.90	101.45	100.08	100.40	100.28	100.40
FeO* %	8.93	8.23	10.21	9.11	10.73	9.70	7.88	7.60	8.04
Mg#	0.469	0.487	0.414	0.416	0.392	0.409	0.422	0.484	0.511
Rb ppm	<1.0	<1.0	4.1	1.1	4.7	10.4	8.9	18.4	14.2
Sr ppm	110	111	140	137	138	169	293	274	285
Ba ppm	14	26	41	95	46	103	419	247	230
Zr ppm	62	63	98	93	94	110	203	166	137
V ppm	265	263	304	285	295	288	289	227	206
Nb ppm	1.6	1.8	4.5	4.4	4.4	13.1	38.5	30.3	24.2
Y ppm	26.1	26.2	33.1	31.6	31.7	31.0	34.2	28.0	23.5
La ppm	3.02	3.10	6.02	5.97	5.89	10.28	28.88	22.51	18.66
Ce ppm	8.55	8.88	15.00	15.01	14.90	23.42	59.27	46.78	39.27
Pr ppm	1.33	1.42	2.19	2.20	2.19	3.04	6.94	5.57	4.68
Nd ppm	7.29	7.76	11.10	11.26	11.30	14.22	29.83	24.15	19.98
Sm ppm	2.61	2.73	3.57	3.55	3.64	4.03	7.04	5.74	4.67
Eu ppm	1.12	1.14	1.46	1.51	1.42	1.55	2.43	2.10	1.68
Gd ppm	3.59	3.85	4.76	4.68	4.76	4.78	7.04	5.97	4.74
Tb ppm	0.70	0.73	0.89	0.88	0.90	0.89	1.17	0.98	0.77
Dy ppm	4.63	4.82	5.90	5.68	5.85	5.59	6.76	5.61	4.50
Ho ppm	0.98	1.02	1.24	1.20	1.23	1.15	1.29	1.08	0.86
Er ppm	2.77	2.89	3.50	3.41	3.47	3.27	3.44	2.90	2.41
Tm ppm	0.42	0.43	0.52	0.50	0.52	0.48	0.49	0.41	0.34
Yb ppm	2.72	2.74	3.34	3.25	3.31	3.10	3.06	2.57	2.11
Lu ppm	0.38	0.40	0.50	0.47	0.49	0.46	0.43	0.36	0.31

show the chemical compositions of basaltic nature with SiO_2 and $\text{Mg}^\#(\text{Mg}/\text{Mg}+\text{FeO}_{\text{total}})$ respectively ranging from 48.96% to 51.09% and from 0.392 to 0.511 and there is no clear difference of these values between the samples of the West and East Areas.

As shown in Figure 3-3-5-1 of the SiO_2 versus TiO_2 , Al_2O_3 , $\text{Na}_2\text{O}+\text{K}_2\text{O}$, P_2O_5 diagram, the basalts of the East Area show a chemical nature of alkali affinities, clearly high in TiO_2 , Al_2O_3 , $\text{Na}_2\text{O}+\text{K}_2\text{O}$ and P_2O_5 , compared to the basalt of the West Area. In SiO_2 - K_2O and AFM diagrams of Figure 3-3-5-2, the basalts of the West Area are plotted in the areas of low-K and tholeiitic series basalt, while the basalts of the East Area in the areas of medium-K and calc-alkali series basalt. Thus, major elements of the basalts suggest that the basalts of the West Area are tholeiitic and the basalts of the East Area are that of alkali affinities. This agrees with the common occurrences of the groundmass olivine in the basalts of the East Area and rare occurrences in the basalts of the West Area.

TiO_2 - MnO - P_2O_5 and Nb-Zr-Y diagrams are shown in Figures 3-3-5-3 and 3-3-5-4, respectively. On these diagrams, the basalts of the West Area are plotted in the field of MORB (Mid-oceanic Ridge Basalt), while the basalts of the East Area are plotted in the field of within-plate alkali basalt.

The spiderdiagram of LIL (large-ion lithophile elements) and HFS (high field-strength elements) and the chondrite normalized patterns of the basalts are shown in the Figures 3-3-5-5 and 3-3-5-6 with typical examples of the basalt from different tectonic environments. The basalts of the West Area show depleted patterns of less than 10 times N-MORB in both LIL and HFS in the spiderdiagram and show light-REE depleted patterns, with 9 to 30 times chondrite, similar pattern transitional from T-MORB (Transitional MORB) to E-MORB (Enriched MORB) in the diagram of chondrite normalized pattern. While, the basalts of the East Area have similar chemical characters transitional from E-MORB (Enriched-MORB) to oceanic island basalt with enriched patterns in spiderdiagram and light REE enriched patterns, 30 to 90 times chondrite, in the chondrite normalized diagram. These variations of chemical nature of the basalt from the two areas occur continuously from the West to the East Areas.

The results of chemical analyses show that the basalts from the West and East Areas have different chemical characteristics; the former is tholeiitic and transitional from T-MORB to E-MORB, the latter is transitional from E-MORB to oceanic island basalt. The chemical diversities of the basalts similar to the above have been reported by Eissen et al. (1994) from the basalts collected at various sites of the Central Spreading Ridge in the north Fiji Basin. According to this, the geochemistry of the

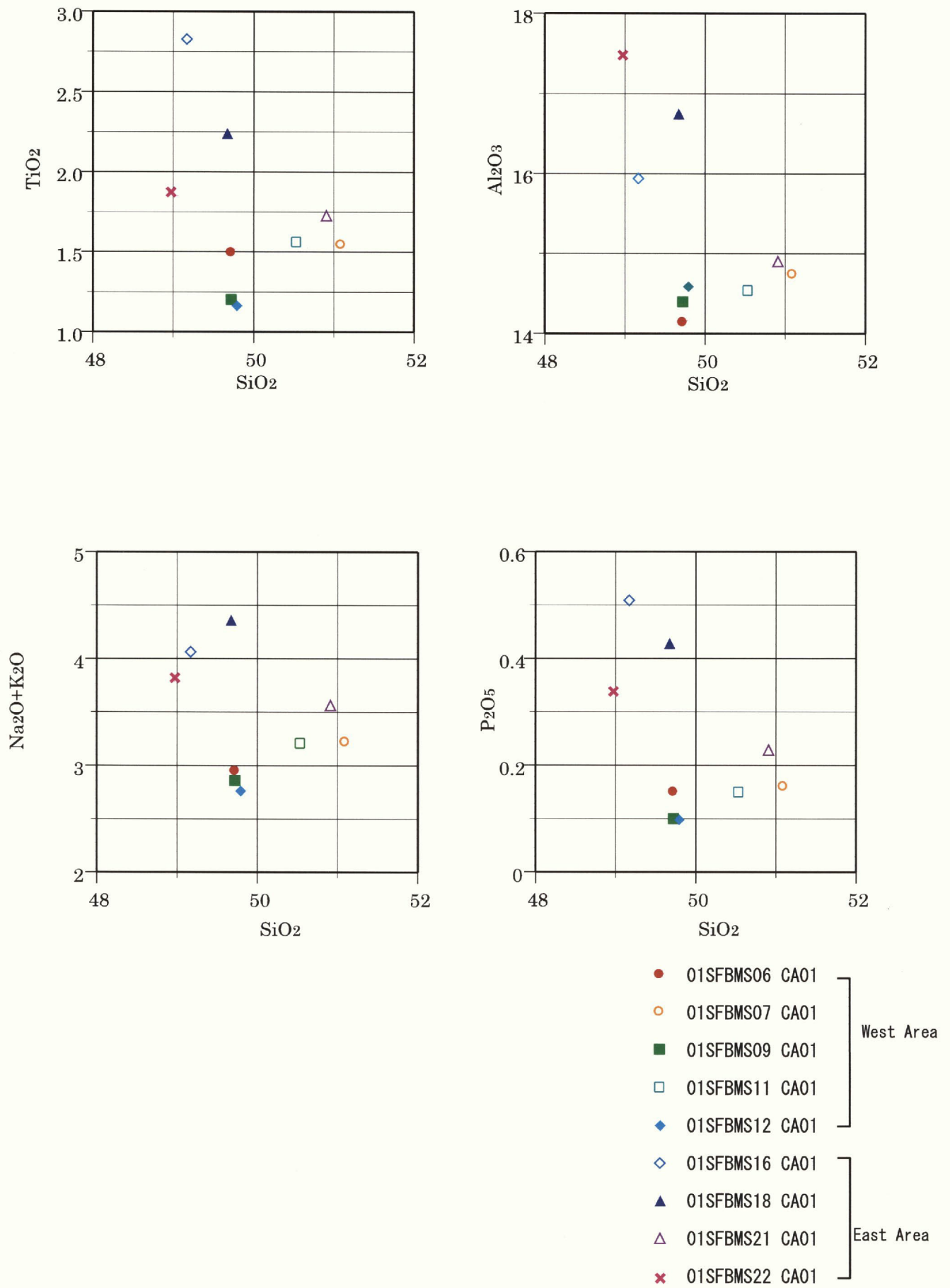


Figure 3-3-5-1 Binary Correlation Diagram Between SiO₂ and Major Elements

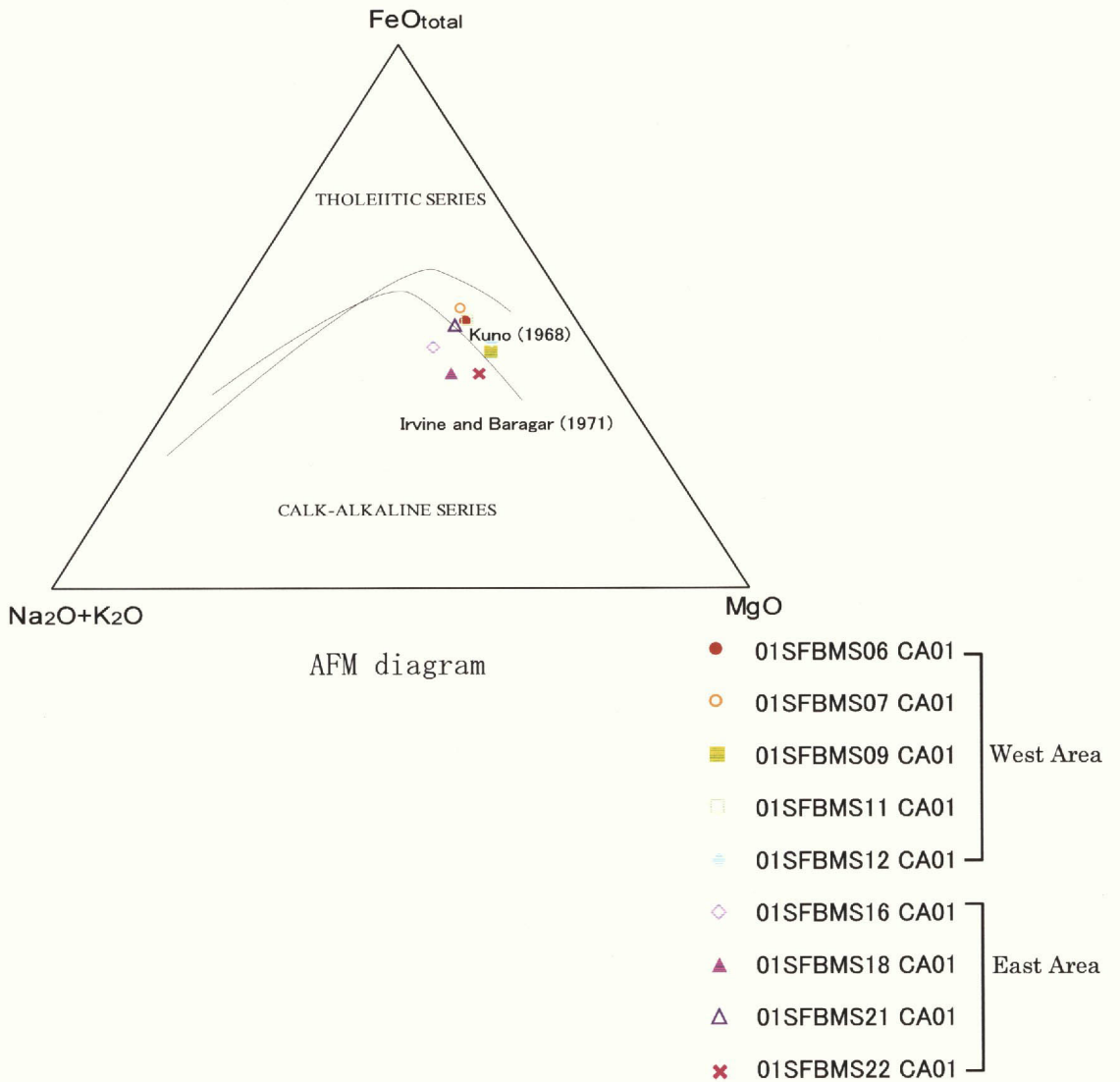
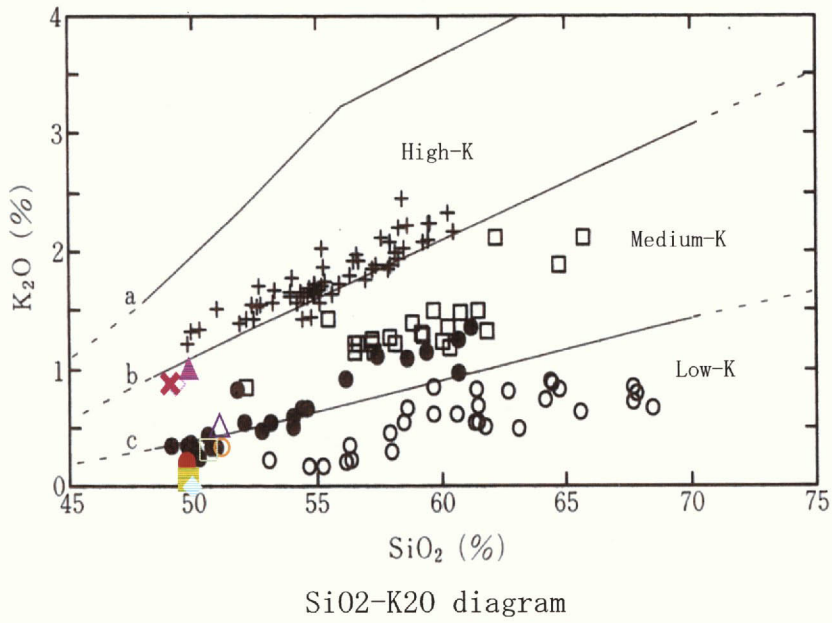
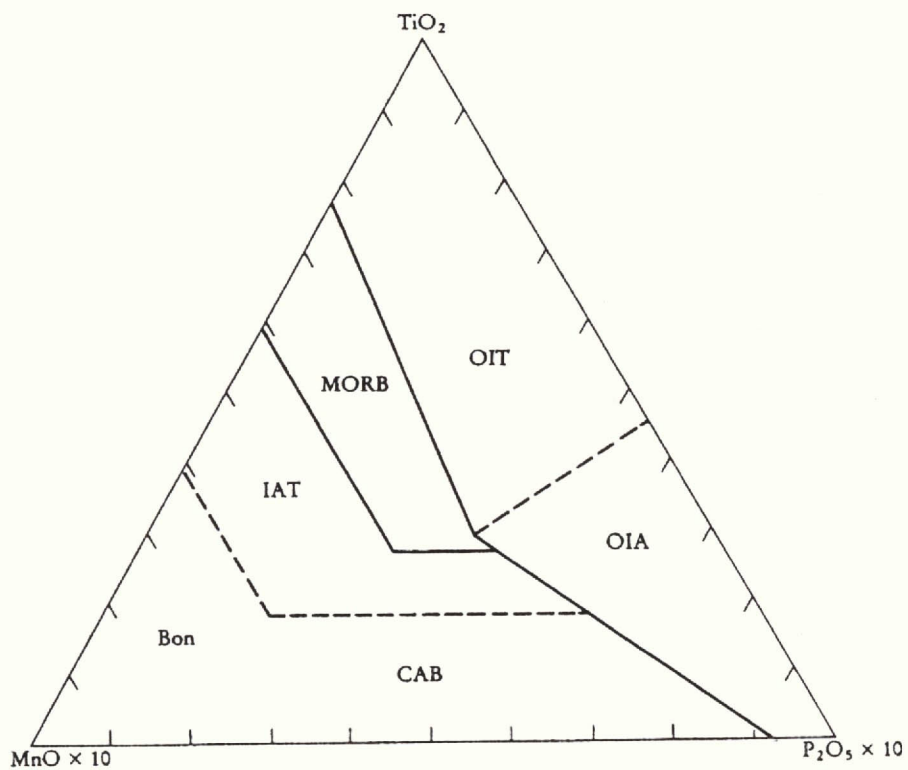
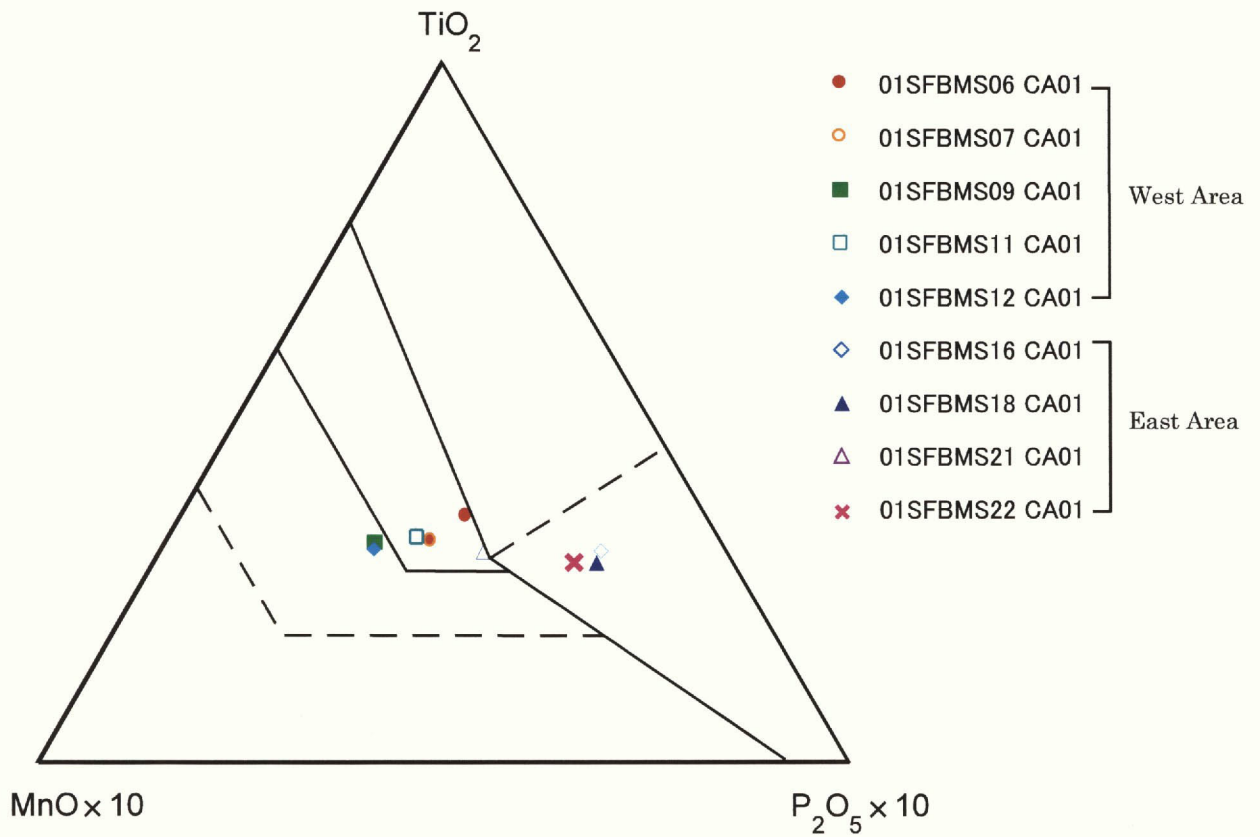
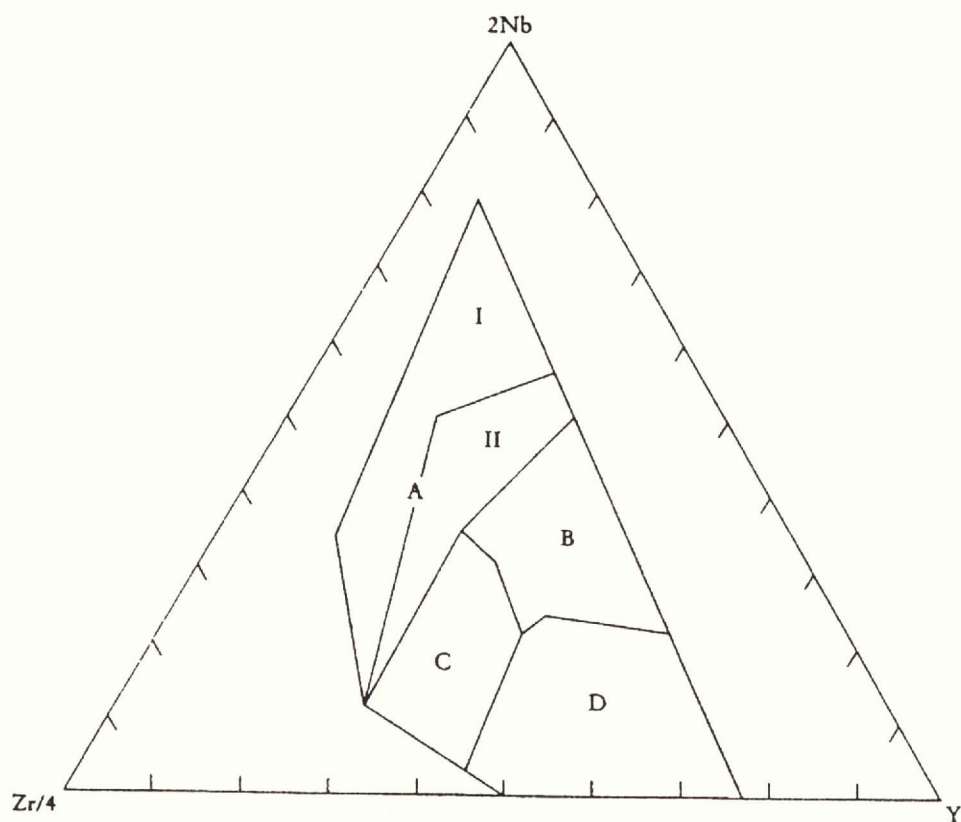
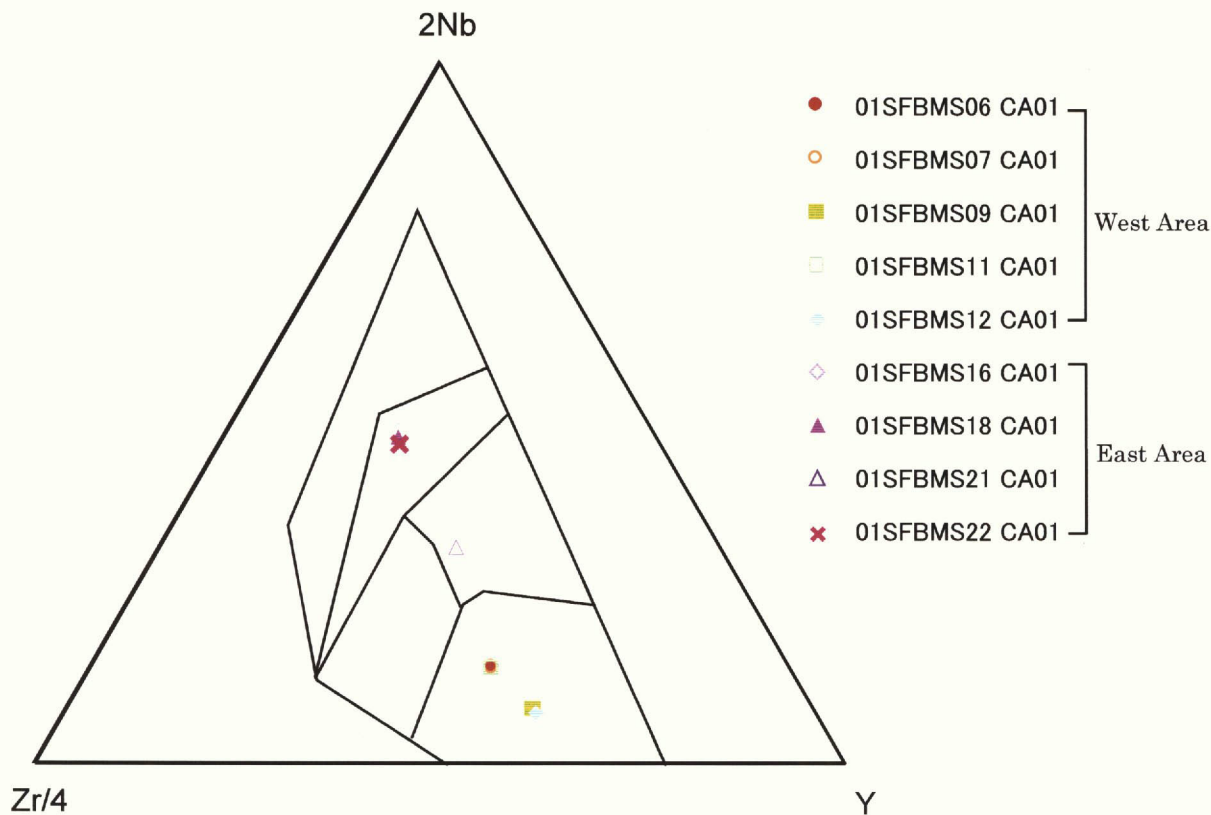


Figure 3-3-5-2 SiO₂-K₂O Diagram and AFM Diagram



The MnO-TiO₂-P₂O₅ discrimination diagram for basalts and basaltic andesites (45–54 wt % SiO₂) (after Mullen, 1983). The fields are MORB; OIT — ocean-island tholeiite or seamount tholeiite; OIA — ocean-island alkali basalt or seamount alkali basalt; CAB — island-arc calc-alkaline basalt; IAT — island-arc tholeiite; Bon — boninite. The boninite field occupies the MnO-rich sector of the CAB field.

Figure 3-3-5-3 TiO₂-MnO-P₂O₅ Diagram



The Zr-Nb-Y discrimination diagram for basalts (after Meschede, 1986). The fields are defined as follows: AI, within-plate alkali basalts; AII, within-plate alkali basalts and within-plate tholeiites; B, E-type MORB; C, within-plate tholeiites and volcanic-arc basalts; D, N-type MORB and volcanic-arc basalts.

Figure 3-3-5-4 Nb-Zr-Y Diagram

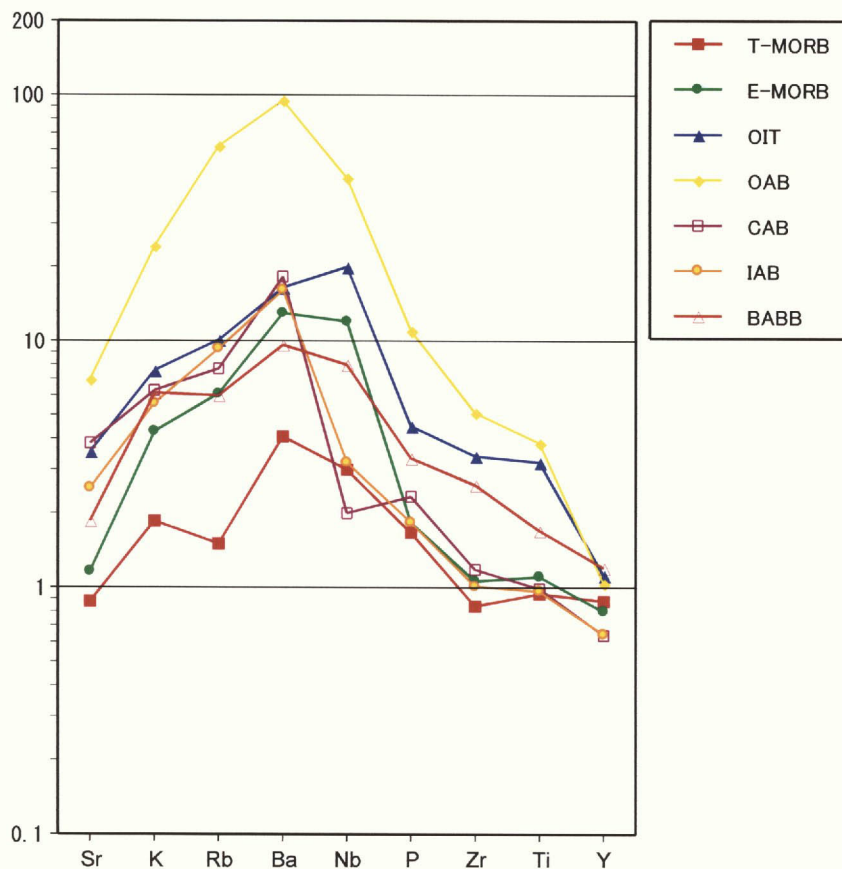
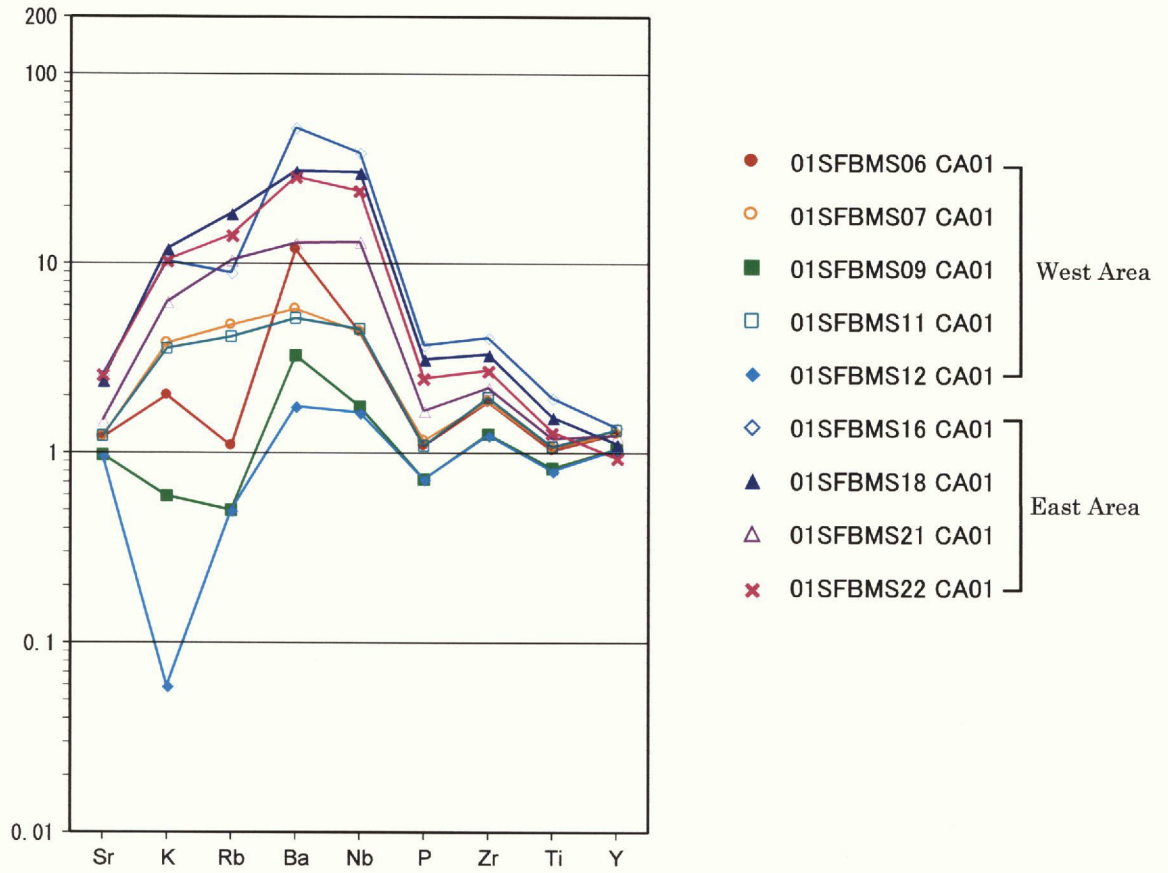


Figure 3-3-5-5 Spiderdiagram

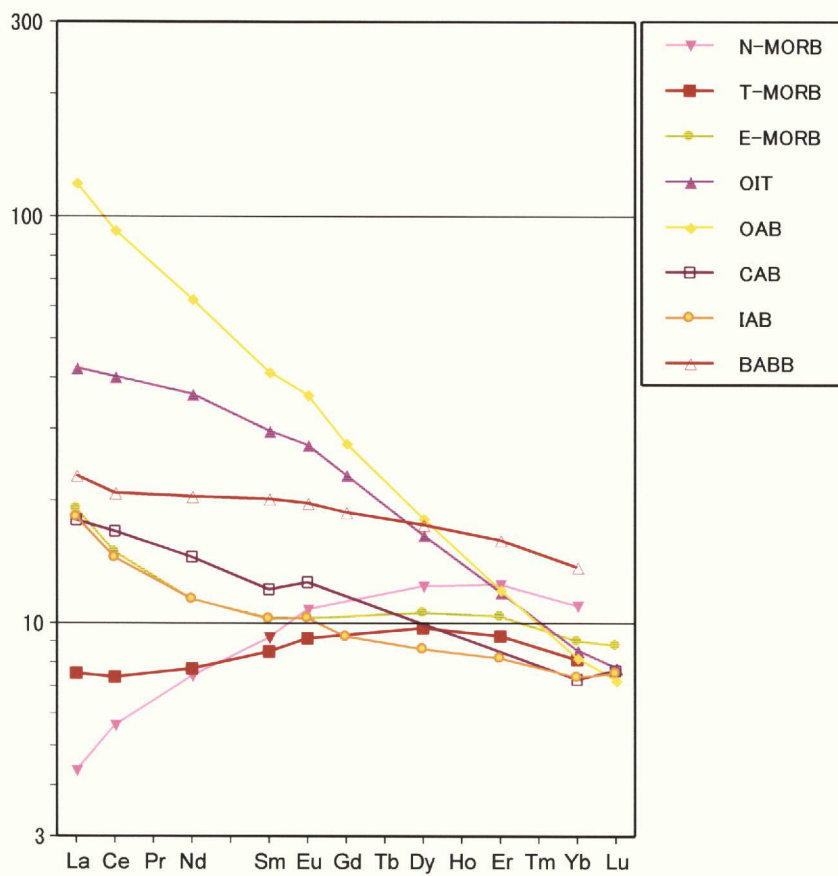
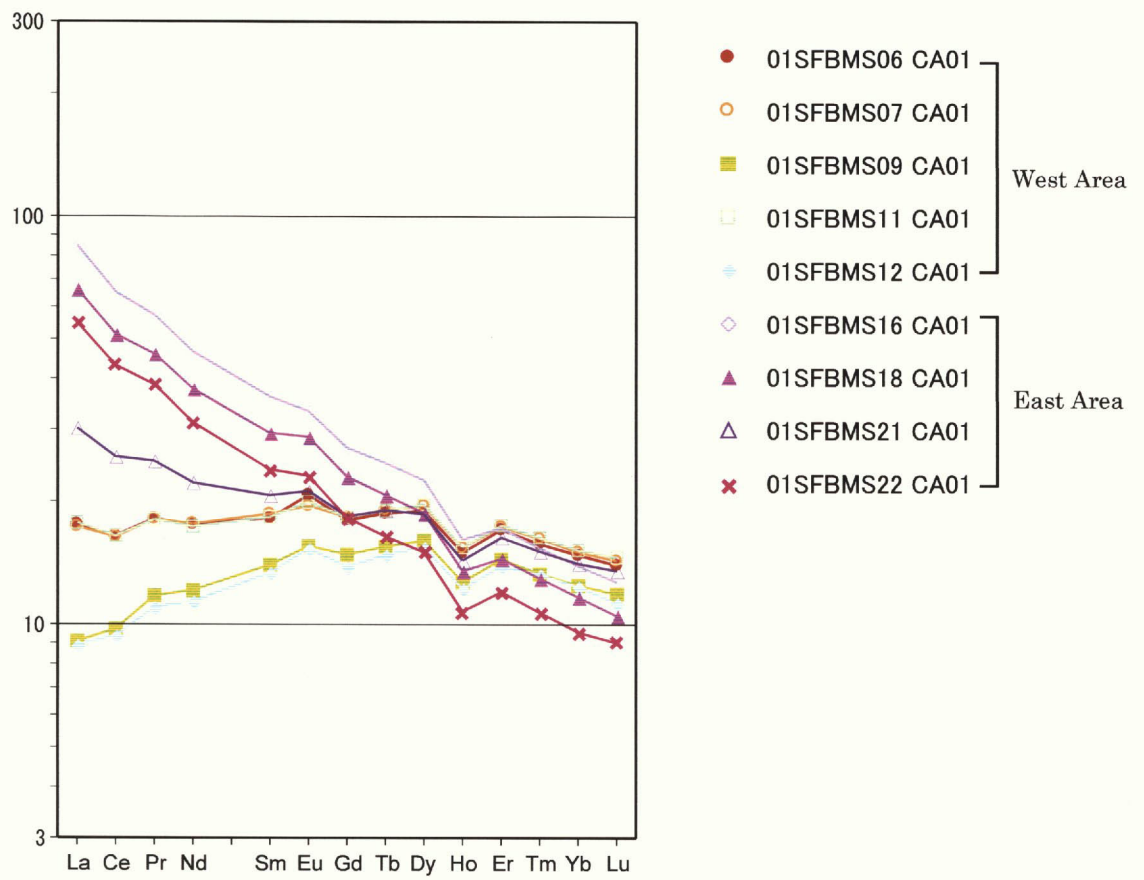


Figure 3-3-5-6 Chondrite Normalized Patterns of REE