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16. *DATA REPORT:* CHEMICAL COMPOSITION OF MIDDLE MIOCENE–LOWER PLIOCENE ASH FROM SITES 982 AND 985[1]

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INTRODUCTION

The Cenozoic volcanic activity on Iceland has been recorded in North Atlantic sediments drilled during several Ocean Drilling Program (ODP)/Deep Sea Drilling Project legs (Legs 104, 151, 152, 162, and 163). Leg 162 (North Atlantic–Arctic Gateways II) recovered ash layers at Sites 982, 985, and 907 (Jansen, Raymo, Blum, et al., 1996). The revisited Site 907 was first drilled during Leg 151, and the ash from this site has been described in detail by Lacasse et al. (1996) and Werner et al. (1996). Site 982 is located within the Hatton-Rockall Basin on the Rockall Plateau, which is situated west of the British Isles. Site 985 is located northeast of Iceland at the foot of the eastern slope of the Iceland Plateau, adjacent to the Norwegian Basin (Fig. 1). Here we report chemical analyses of Neogene tephra layers from Holes 982A, 983B, 982C, 985A, and 985B.

The sedimentary sequence at Site 982 (for site positions, depths, etc., see Table 1) spans the lower Miocene–Holocene; Site 985 recovered sediments spanning the upper Oligocene–Holocene (Fig. 2). Twenty-two distinct ash layers and ash-bearing sediments were sampled in Holes 982A–982C (Cores 162-982A-16H through 24H, 162-982B-14H through 56X, and 162-982C-15H through 27H), and 59 ash layers were sampled in Holes 985A and 985B (Cores 162-985A-11H through 59X, and 162-985B-11H through 14H). Almost 50% of the sampled ash is strongly altered (predominantly from Site 985). A cluster of altered thin layers in the lower Pliocene of Site 985 (top of Unit III) is remarkable.

METHODS

On the basis of shipboard descriptions (visual core descriptions, barrel sheets, smear-slide descriptions; Shipboard Scientific Party, 1996a, 1996b), 83 ash layers and ash-bearing sediments were sampled at one or two depth intervals (tops and bottoms of the layers), depending on layer thickness. Thin sections were made from all samples.

Texture, mineralogical and lithological composition, and alteration of all samples were studied in thin sections. Thirty-five samples containing fresh glass particles were selected for chemical analyses. Major-element compositions and volatile contents (S, Cl, and F) of fresh glass particles were determined using a CAMECA SX50 electron microprobe. The microprobe was operated at an accelerating voltage of 15 kV and a beam current of 10 nA, with 20 s on-peak + 10 s on-background counting times. To minimize sodium loss, felsic glasses were analyzed with the beam rastered (TV mode), scanning an area of 9 µm × 13 µm (magnification 10,000×). The results (Table 2) show that under the chosen conditions sodium loss (as well as potassium loss) is negligible. Natural glass standards JDF-D2 (mid-ocean ridge basalt [MORB]-glass; C.H. Langmuir, pers. comm., 1993), ALV-981R23-5 (submarine basaltic glass; Fine and Stolper, 1986; Metrich and Clocchiatti, 1989), LIPARI (obsidian, Lipari, Cannetto Lami lava; Hunt and Hill, 1993), and KN 18 (rhyolitic glass; Nielson and Sigurdsson, 1981) were run for major-element analyses. SCAPOLITE USNM R6600-1 and SPHALERITE (synthetic zinc sulfide) standards were used to calibrate the electron microprobe for sulfur, SCAPOLITE for chlorine, and SI-F-APATITE USNM 104021 for fluorine. Additional basaltic and rhyolitic glass standards (e.g., VG-2) and interlaboratory monitors (e.g., ISL 89/15 Icelandic tholeiitic glass) were analyzed periodically to monitor the accuracy of the microprobe. We considered the effect of sulfur speciation (S^{6+} or S^{2-}) on the S-Kα spectral peak position, assuming sulfur to be S^{6+} in SCAPOLITE and S^{2-} in SPHALERITE in the analyzed samples (measured spectrometer positions corresponding to sinθ: SCAPOLITE = 61370; SPHALERITE = 61407; selection of the analyzed samples = 61404 ± 6). For the analyzed standards, the standard deviation (2σ) for major elements is <0.4 wt% (Table 2). Sulfur concentrations of 1160 ± 120 ppm (2σ) obtained for the standard ALV-98 correspond to the values of 1170 ± 90 ppm reported by Metrich and Clocchiatti (1989) and 1050 ± 140 ppm reported by Metrich et al. (1991).

To smooth out compositional heterogeneities, as many as 10 points were analyzed on each glass particle. The data presented here are averages of these analyses. As many as 32 individual glass particles were analyzed for each ash deposit.

RESULTS

Lithology and Stratigraphy

Volcanic glass occurs as light to dark brown, ± opaque (tachylitic), and colorless fragments in ash horizons with contents of glass particles varying from ~10% to 90%. Three types of ash deposits can be distinguished on the basis of structure and modal compositions: (1) discrete ash layers contain >80% glass particles and have a sharp base and a gradational top (AL in Table 3); (2) disseminated ash layers contain 10%–80% glass particles (DA in Table 3); and (3) ash-enriched layers are deposits with ≤10% glass particles (EL in Table 3).

Ash layers from Site 982 were sampled in lithologic Subunits IIA–IID, which range from the middle Miocene to the lower Pliocene (~18.8–~5 Ma). These sediments comprise a sequence of marine nannofossil oozes and chalks with minor amounts of clay, clayey nannofossil mixed sediments, and clays, with variable amounts of nannofossils and silt—all deposited above the calcite compensation depth.

Tertiary ash layers of Site 985 are distributed throughout lithologic Units II–V, which range in age from late Oligocene to early Pliocene (<24–~5 Ma). The sediments are predominantly fine-grained siliciclastics (silty clays; clays with silt and clays). Biogenic carbonate in significant amounts (>10%) is restricted to the upper part of the sequence (Units I–III). The increasing silt content of Unit III sediments may mark the transition from the relatively ice-free conditions of the Miocene to the weak Northern Hemisphere glacia-

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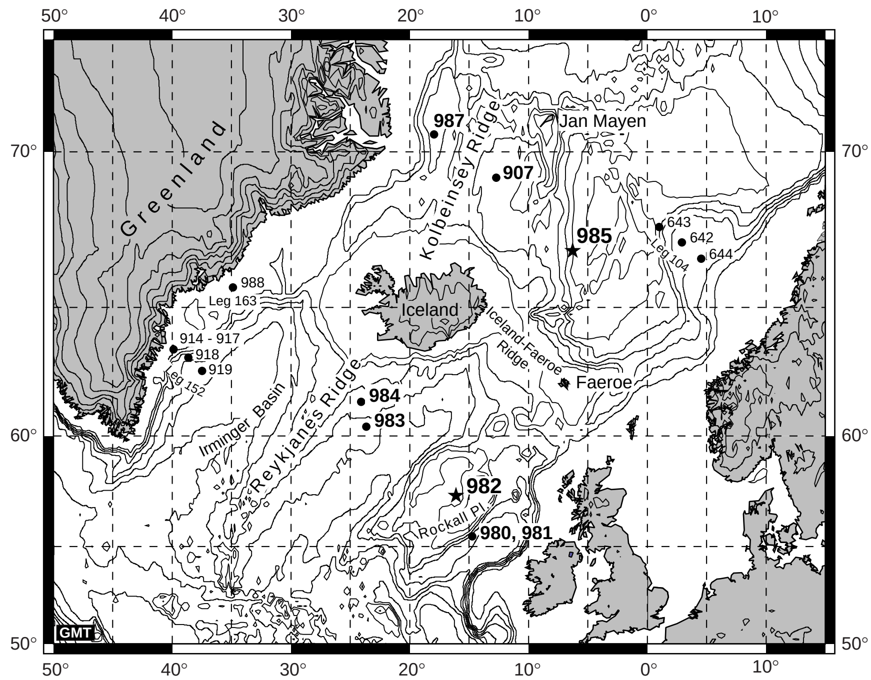

Figure 1. Map of the central North Atlantic showing locations of ODP sites (stars and large site numbers represent Leg 162).

Table 1. Holes, positions, water depth, drilling statistics, and stratigraphy for Sites 982 and 985.

	Site 982				Site 985	
	Hatton-Rockall Basin				Iceland Plateau	
Hole:	982A	982B	982C	982D	985A	985B
Latitude:	57°30.992′N	57°30.992′N	57°30.992′N	57°0.992′ N	66°56.490′N	66°56.498′N
Longitude:	15°52.001′W	15°52.001′W	15°52.001′W	15°52.00 1′W	6°27.012′W	6°27.001′W
Water depth (m):	1135.3	1134.0	1133.7	1133.7	2787.6	2787.8
Total penetration (m):	248.7	614.9	250.8	29.5	587.9	126.9
Total length of cored section (m):	248.7	614.9	250.8	9.5	587.9	126.9
Drilled (mbsf):	—	—	—	20.0	—	—
Core recovery (%):	101.7	79.4	102.3	101.8	94.1	102.0
Oldest sediment cored:						
Depth (mbsf):	248.7	614.9	250.8	29.5	587.9	126.9
Earliest age:	late Miocene	early Miocene	late Miocene	Pleistocene	late Oligocene (?)	late Miocene
Lithostratigraphic summary:	Figure 2	Figure 2	Figure 2	—	Figure 2	Figure 2

Notes: Data taken from Jansen, Raymo, Blum, et al. (1996). — = hole completely cored.

tion from the late Pliocene to the Holocene (Shipboard Scientific Party, 1996b).

The oldest sampled ash layers belong to the Oligocene (Hole 985A, Unit V). These ashes were not analyzed because of their high degree of alteration. The oldest fresh ash layers occur in Hole 983A (Subunit IVB) and Hole 982B (Subunit IID) and are middle Miocene in age (Fig. 2).

Structure, Texture, and Composition

Nearly three-quarters of the ash deposits studied here are discrete ash layers (tephra) with sharp bases and gradational or diffuse upper boundaries (AL in Table 3). The layers are <1–24 cm thick and consist of 80%–98% of colorless and/or brown glass particles. Rock fragments, crystals (mostly feldspar, with minor amounts of pyroxene, amphibole, olivine, quartz, mica, zeolites, glauconites, and opaque minerals), and fossils are subordinated. The colorless glass is dominated by highly vesicular fragments, Y-shaped bubble-wall shards, and pumice fragments. Colored glass mostly has a blocky shape. Compared to ash layers from Legs 151 (Lacasse et al., 1995, 1996; Werner et al., 1996) and 152 (Werner et al., 1998; Lacasse et al., 1998), greater amounts of highly vesicular and/or pumiceous brown glass shards are present (Table 3). The high glass content suggests that these ash layers are primary deposits or are volcanic deposits that are minimally reworked.

About one-quarter of the studied ash deposits are ash-bearing to ash-rich sediments, with 5%–80% glass content mixed with nonvolcanic material (DA in Table 3). These layers are interpreted as epiclastic deposits, transported and deposited as turbidites.

Unique when compared with other ODP sites in the North Atlantic (e.g., Bitschene et al., 1989; Lacasse et al., 1996; Lacasse et al., 1998; Werner et al., 1996; Werner et al., 1998) is the low abundance of pure mafic ashes (~10% of all analyzed ash layers) and the relatively high abundance of bimodal ashes (~45%) in the Miocene sequence of Sites 982 and 985. Also remarkable is the high amount of strongly altered ash at Site 985.

Major-Element Composition

The analytical totals of major-element analyses (electron microprobe) for the lower Pliocene–middle Miocene ash layers from Sites 982 and 985 range from ~88 to 96 wt% for felsic glasses and from 96 to 100 wt% for mafic and intermediate glasses (with iron calculated as FeO* = total Fe as [FeO + Fe_2O_3]). The low totals of felsic glasses

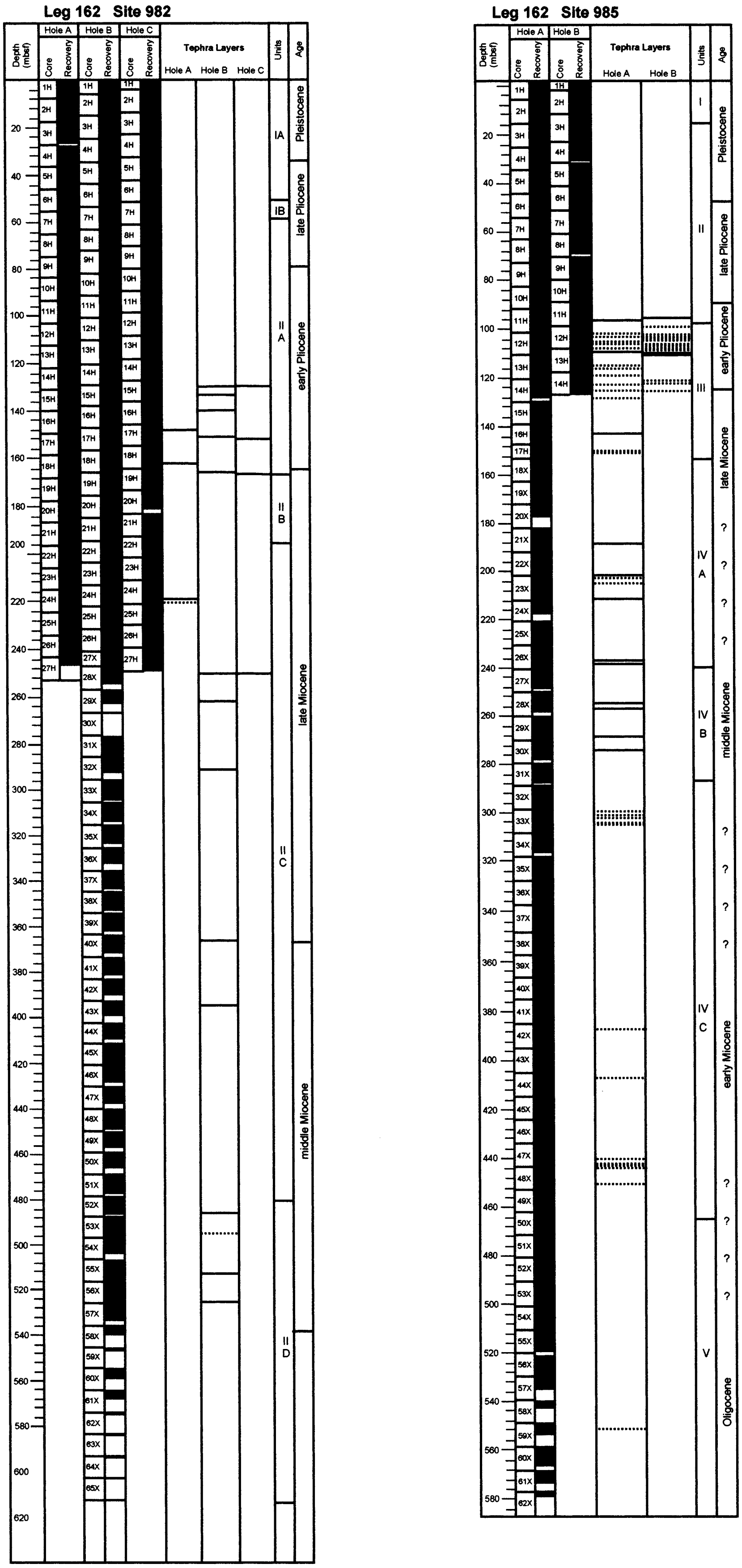

Figure 2. Lithostratigraphy and stratigraphic position of ash-bearing sediments of the lower Pliocene–Oligocene sedimentary sequence recovered at Sites 982 and 985 (Shipboard Scientific Party, 1996a, 1996b; stratigraphic boundaries with minor revisions after Spiegler, Chap. 3, this volume). Dashed lines indicate highly altered ash. For hole-to-hole correlation, see Table 3.

Table 2. Comparison of major-element analyses of glass standards.

	LIPARI				KN18		
	XRF (J. Sparks, pers. comm., 1990)	(Hunt and Hill, 1993)	(This study) *N* = 30	(This study) SD	(Nielson and Sigurdsson, 1981)	(This study) *N* = 30	(This study) SD
SiO_2	74.03	74.35	73.94	0.20	74.60	74.77	0.36
TiO_2	0.08	ND	0.09	0.03	0.18	0.19	0.03
Al_2O_3	12.72	12.87	12.95	0.07	10.53	10.51	0.09
Fe_2O_3	1.73	ND	ND		ND	ND	0.00
FeO*	ND	1.51	1.50	0.07	3.45	3.38	0.10
MnO	0.08	0.07	0.07	0.04	0.06	0.06	0.03
MgO	0.00	0.05	0.05	0.02	ND	0.01	0.01
CaO	0.72	0.74	0.73	0.04	0.15	0.15	0.06
Na_2O	4.06	3.93	4.25	0.04	5.68	5.65	0.05
K_2O	5.18	5.11	5.10	0.07	4.39	4.28	0.07
P_2O_5	ND	ND	ND		ND	0.03	0.02
LOI	1.04						
Total	99.64	98.63	98.68		99.04	99.03	

Table 2 (continued).

	ALV-98				JDF-D2		
	(Fine and Stolper, 1986)	(Metrich and Clocchiatti, 1989)	(This study) *N* = 50	(This study) SD	(C.H. Langmuir, pers comm., 1993)	(This study) *N* = 50	(This study) SD
SiO_2	49.53	49.70	49.57	0.38	50.80	50.56	0.22
TiO_2	1.27	1.25	1.24	0.11	1.93	1.90	0.12
Al_2O_3	16.58	16.92	16.43	0.27	13.80	13.63	0.21
FeO*	8.42	8.70	8.41	0.18	12.17	12.06	0.19
MnO	0.14	0.15	0.18	0.03	0.22	0.23	0.04
MgO	8.68	8.52	8.77	0.12	6.83	6.71	0.07
CaO	11.81	11.05	12.06	0.13	10.80	10.84	0.12
Na_2O	2.88	3.05	2.81	0.03	2.77	2.69	0.03
K_2O	0.05	0.05	0.05	0.02	0.22	0.23	0.02
P_2O_5	0.06	ND	0.07	0.03	0.23	0.22	0.03
Total	99.42	99.56	99.59		99.77	99.08	

Notes: Unless noted, the analyses were performed using an electron microprobe. XRF = X-ray fluorescence. SD = standard deviation (2σ). FeO* = total Fe as (FeO + Fe_2O_3). ND = not determined.

probably result from the high content of initial volatiles of up to 7 wt% H_2O (Bitschene and Schmincke, 1990) and/or are a result of hydration and alteration with a significant loss of alkali elements (Na_2O, and K_2O). Therefore, analyses with totals <93 wt% (felsic glasses) and <98 wt% (mafic and intermediate glasses), respectively, are not shown in the diagrams presented in this report.

Figure 3 shows the total alkali vs. silica distribution of the analyzed samples. The geochemical spectrum ranges from basalt to low-alkali and high-alkali andesites, andesites, dacites, and rhyolites. Except for two layers depleted in alkali elements (Samples 162-985A-26X-6, 0–3 cm, and 28X-5, 22–27 cm), the alkali vs. silica distributions of the ash layers of Sites 982 and 985 are very similar. More than 90% of brown glass fragments of the two sites are basaltic to basaltic-andesitic, and nearly 100% of the colorless glasses are rhyolitic. Two layers from Site 982 and one from Site 985 are andesitic; three fragments of one layer of Site 985 are dacitic.

At Site 982, ~60% of ash layers consist of one or two chemically homogeneous fractions. Half of these layers contain one to three fragments with a different chemical composition (indicated by an asterisk in Tables 4 and 5). The remaining ash layers show a wide variability in chemical composition. In one of these layers (interval 162-982B-18H-6, 49–50 cm), a trend from mafic to felsic compositions is recognized.

The amount of chemically more or less homogeneous tephra is somewhat higher at Site 985 (~70%). A trend from mafic to felsic compositions is visible in two layers (intervals 162-985A-23X-11, 12–14 cm, and 26X-6, 55–57 cm; Table 5). The remaining ash layers are highly variable in chemical composition.

Figure 4 shows the analyses of individual mafic to intermediate glass shards; SiO_2, Al_2O_3, CaO, FeO*, K_2O, and TiO_2 are plotted vs. MgO, an index of differentiation. All analyses show increasing SiO_2 and K_2O and decreasing CaO, FeO*, and TiO_2 as MgO decreases.

Most of the rhyolitic glass shards are compositionally homogeneous. Figure 5 depicts the major-element composition of only the rhyolitic glasses; Al_2O_3, CaO, FeO*, and K_2O are plotted vs. SiO_2. With a few exceptions, Al_2O_3 and FeO* decrease with increasing SiO_2, CaO is relatively constant and low (<3 wt%), but K_2O ranges between ~2 and ~5 wt% and has no significant trend. A few glasses plot outside of the major groups. Most of the ash belongs to the low-potassium series (<3.8 wt% K_2O) defined by Sigurdsson and Loebner (1981) for North Atlantic ashes. All rhyolites have an Icelandic affinity (Figs. 3, 6). Moreover, most analyses match the field for highly evolved rocks of the Tertiary Icelandic central volcanoes Thingmuli and Breiddalur (Figs. 6A, 7; Walker, 1963; Carmichael, 1964). The basaltic to andesitic and dacitic glasses also correspond to mafic and intermediate rocks of these Tertiary Icelandic central volcanoes, at least in major-element composition (Figs. 6A–D, 7). Furthermore, the glasses clearly follow the Thingmuli tholeiitic trend (Carmichael, 1964) as shown in the FeO* vs. MgO plot (Fig. 6D). Even though the comparison of whole-rock analyses (data from Carmichael, 1964, and Walker, 1963) and analyses of matrix glasses (this study) is difficult because of the effect of crystallization, the correspondence in concentrations of incompatible elements (e.g., TiO_2 and K_2O) indicates an Icelandic source area.

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Table 3. Type, stratigraphic setting, textural characteristics, and composition of ash layers and ash-bearing sediments recovered at Sites 982 and 985 (early Pliocene and Oligocene sequences).

Label	Type	Core, section, interval (cm)	Depth (mbsf)	Corrected depth (mcd*)	Thickness (cm)	Colorless glass Abundance	Colorless glass Glass type	Brown glass Abundance	Brown glass Glass type	Correlative samples	Comments
162-982A-											
982-1	*DA?*	*16H-6, 4-6*	*148.74-148.76*	*166.86-166.88*	*2*	***	*bw*			*982-8, -20*	*20% volcanic glass*
982-2	*AL?*	*18H-2, 90-92*	*162.60-162.62*	*182.10-182.12*	*2*	***	*bw, p*			*982-9, -21*	*Nannofossil ooze with ash*
982-3	*DA?*	*24H-2, 70-80*	*219.40-219.50*	*243.59-243.69*	*10*	*	*bw, v, (p)*				*20% volcanic glass*
982-4	DA?	24H-3, 20-39	220.40-220.59	244.59-244.78	19						Mixed sediment
162-982B-											
982-5	*AL*	*14H-CC*	*129.00*	*141.60*	*4*	***				*982-19*	
982-6	*AL*	*15H-3, 129-130*	*133.29-133.30*	*147.35-147.36*	*1*	***	*bw, (p)*	*			
982-7	*DA*	*16H-2, 62-64*	*140.62-140.64*	*155.36-155.38*	*2*	***	*bw, (p)*				*Burrow?*
982-8	*AL*	*17H-3, 27-40*	*151.27-151.40*	*166.86-166.99*	*13*	**	*bw*			*982-1, -20*	*45% volcanic glass*
982-9	*AL*	*18H-6, 42-50*	*165.42-165.50*	*182.00-182.08*	*8*	**	*bw*	*	*bl, (v)*		*Diffuse top*
982-10	*AL*	*28X-1, 85-100*	*250.15-250.30*	*270.74-270.89*	*15*	**	*bw, v*	* *p.alt.*		*982-22*	*20% volcanic glass*
982-11	*AL*	*29X-3, 67-70*	*262.57-262.60*	*283.16-283.19*	*3*	*** *p.alt.*	*bw*	* *p.alt.*			
982-12	*DA*	*32X-4, 4-15*	*292.34-292.45*	*312.93-313.04*	*11*	***	*bw*	***	*v*		
982-13	*DA*	*40X-2, 0-10*	*366.40-366.50*	*386.99-387.09*	*10*			**	*bl, v*		
982-14	*AL*	*43X-2*	*395.30*	*415.89*	*2.5*	**	*bw*	** *p.alt.*	*v, bl*		*90% volcanic glass, highly vesicular particles*
982-15	*AL*	*52X-4, 108-112*	*485.78-485.82*	*506.37-506.41*	*4*	***	*bw, v*	**	*v, (bl)*		
982-16	EL?	53X-4, 75-85	494.95-495.05	515.54-515.64	10	** p.alt.		* p.alt.			10% volcanic glass
982-17	*AL*	*55X-3, 146*	*513.36*	*533.95*	*4*			**	*v, bl*		
982-18	*?*	*56X-6, 55-58*	*526.55-526.58*	*547.14-547.17*	*3*	** *p.alt.*	*bw, v, p*				*Dark layer*
162-982C-											
982-19	*AL*	*15H-1, 135-139*	*128.65-128.69*	*141.73-141.77*	*4*	***	*v, bw*	*	*bl, v*	*982-5*	
982-20	*AL*	*17H-4, 124-126*	*152.04-152.06*	*166.49-166.51*	*2*	***	*bl, bw*	*	*v, (bl)*	*982-1, -8*	*79% volcanic glass, highly vesicular brown glass*
982-21	*AL*	*19H-1, 8-9*	*165.38-165.39*	*181.81-181.82*	*1*	***	*bw, bl, (v, p)*	**	*v, bl*	*982-9, -2*	*Blackish layer*
982-22	*AL*	*27H-6, 120-130*	*250.00-250.10*	*270.66-270.76*	*10*	***	*v, bw, bl, p*	* *p.alt.*		*982-10*	*Top diffuse, 45% volcanic ash*
162-985A-											
985-1t	*AL*	*11H-3, 33-57*	*96.53-96.77*	*102.87-103.11*	*24*	***	*v, bl*			*985-46t*	*Top of ash layer*
985-1b	*AL*	*11H-3, 33-57*	*96.53-96.77*	*102.87-103.11*	*24*	***	*v, bw*	*		*985-46b*	*Base of ash layer*
985-2	AL	12H-1, 5-8	102.75-102.78	109.73-109.76	3	*alt		*			
985-3	AL	12H-1, 60-62	103.30-103.32	110.28-110.30	2	* p.alt.		* alt			
985-5	AL	12H-2, 66	104.86	111.84	1			* alt		985-66	Feldspar
985-6	AL	12H-3, 63-64	106.33-106.34	113.31-113.32	1			* alt		985-67	Feldspar
985-7	AL	12H-4, 80	108.00	114.98	0.5			* alt		985-69	Feldspar
985-8	*AL*	*12H-5, 110*	*109.80*	*116.78*	*1.5*	***	*bw, v, (bl)*				
985-9	AL	13H-3, 57-59	115.77-115.79	123.26-123.28	2	* p.alt.		* alt			
985-11	AL	13H-4, 3-6	116.73-116.76	124.22-124.25	3			* p.alt.			
985-12	AL	13H-5, 107-108	119.27-119.28	126.76-126.77	1	*alt		* alt			
985-13	AL	14H-2, 39-40	123.19-123.20	130.94-130.95	1	*					
985-14	AL?	14H-3, 139-143	125.69-125.73	133.53-133.57	4	**alt				985-81	Pumice fragments up to 5mm Ø
985-15	AL	14H-6, 47-49	129.27-129.29	137.11-137.13	2	*alt		* alt			
985-16	*AL*	*16H-2, 82-93*	*143.02-143.11*	*150.86-150.95*	*9*	***	*bw, bl, p*				
985-18	AL	17H-2, 87-96	151.27-151.36	159.11-159.20	9	*** alt					
985-19	AL	17H-2, 141-146	151.81-151.86	159.65-159.70	5	*** alt					
985-20	*AL*	*21X-4, 62-68*	*188.92-188.98*	*196.76-196.82*	*6*	*	*v, bw, p*	**	*bl, v*		*Highly vesicular basaltic glass*
985-21	*AL*	*23X-1, 10-15*	*203.10-203.15*	*210.94-210.99*	*5*	**	*v, bw*	**	*bl, v*		
985-22	AL	23X-2, 98-99	205.48-205.49	213.32-213.33	1	** p.alt.					

Table 3 (continued).

Label	Type	Core, section, interval (cm)	Depth (mbsf)	Corrected depth (mcd*)	Thickness (cm)	Colorless glass		Brown glass		Correlative samples	Comments
						Abundance	Glass type	Abundance	Glass type		
985-23	AL	23X-7, 22-31	212.22-212.31	220.06-220.15	9	*** alt					
985-24	*AL*	*26X-4, 46-58*	*236.76-236.88*	*244.60-244.72*	*12*	*** *p.alt.*	*bw*				
985-25	*AL*	*26X-6, 0-3*	*239.30-239.33*	*247.14-247.17*	*4*			***			*Continuation from 162-985A-26X-5, 149-150 cm*
985-26	*AL*	*26X-6, 53-59*	*239.83-239.89*	*247.67-247.73*	*6*	*** *p.alt.*	*v, bw, (bl)*	*	*bl, v*		
985-27	*DA/EL?*	*28X-3, 73-83*	*254.83-254.93*	*262.67-262.77*	*10*	***	*bl, bw*				
985-28	*DA/EL?*	*28X-5, 22-27*	*257.32-257.37*	*265.16-265.21*	*5*			***	*v, bl*		
985-29	*DA*	*29X-5, 143-150*	*268.13-268.20*	*275.97-276.04*	*7*	***	*bw, bl, v*	* *p.alt.*	*bl*		*65% volcanic glass*
985-31	*AL*	*30X-3, 112-122*	*274.42-274.52*	*282.26-282.36*	*10*	*		**	*bl, v*		
985-32	AL?	33X-1, 69-75	299.89-299.95	307.73-307.79	6	*** alt		alt			
985-33	AL	33X-2, 28-34	300.98-301.04	308.82-308.88	6	*** alt					
985-34	AL?	33X-2, 128-134	301.98-302.04	309.82-309.88	6	** alt		** alt			
985-35	AL	33X-3, 19-20	302.39-302.40	310.23-310.24	1			** alt			
985-36	AL	33X-3, 112	303.32	311.16							
985-37	AL	33X-4, 38-42	304.08-304.12	311.92-311.96	4						
985-38	AL	42X-2, 53-55	387.53-387.55	395.37-395.39	2						
985-39	AL	44X-2, 119-121	407.69-407.71	415.53-415.55	2						
985-40	AL	47X-5, 33-36	440.33-440.36	448.17-448.20	3						
985-41	AL	47X-6, 124-126	442.74-442.76	450.58-450.60	2						
985-42	AL	47X-7, 149-150	444.49-444.50	452.33-452.34	2						Continuation from 162-985A-47X-6, 149
985-43	AL	47X-7, 12-16	443.12-443.16	450.96-451.00	4						
985-44	?	48X-5, 69-71	450.29-450.31	458.13-458.17	2						77% volcanic glass
985-45	AL	59X-2, 82-84	551.52-551.54	559.36-559.38	2						
162-985B-											
985-46t	*AL*	*11H-5, 88-111*	*95.78-96.01*	*102.89-103.12*	*23*	***	*bw, (bl)*			*985-1t*	*Top ash layer*
985-46b	*AL*	*11H-5, 88-111*	*95.78-96.01*	*102.89-103.12*	*23*	***	*bl, v, (bw)*			*985-1b*	*Base ash layer*
985-48	AL	12H-1, 136-137	99.76-99.77	106.87-106.88	1						
985-49	AL	12H-2, 92-94?	100.82-100.84	107.93-107.95	2						
985-58	AL	12H-3, 121	102.61	109.62							Several small ash layers between 109 and 141 cm
985-59	AL	12H-3, 132	102.72	109.73							Several small ash layers between 109 and 141 cm
985-64	AL	12H-4, 4-8	102.94-102.98	109.95-109.99	4						
985-65	AL	12H-4, 57-59	103.47-103.49	110.48-110.50	2						
985-66	AL	12H-5, 47-48	104.87-104.88	111.88-111.89	1					985-5	
985-67	AL	12H-6, 30-31	106.20-106.21	113.21-113.22	1					985-6	Feldspar
985-68	DA	12H-6, 63-68	106.53-106.58	113.54-113.59	5						
985-69	DA	12H-7, 33-41	107.73-107.81	114.74-114.82	8					985-7	
985-70	AL	12H-7, 54-55	107.94-107.95	114.95-114.96	1						
985-72	AL	13H-1, 92-94	108.82-108.84	117.46-117.48	2						
985-75	*AL*	*13H-2, 123-131*	*110.63-110.71*	*119.27-119.35*	*8*	***	*bw, v, bl, (p)*				
985-78	*AL*	*13H-3, 50-53*	*111.40-111.43*	*120.04-120.07*	*3*	***	*bw, v, bl*				
985-79	AL	14H-3, 145-146	121.85-121.86	131.18-131.19	1						
985-80	AL	14H-4, 24-27	122.14-122.17	131.47-131.50	3						Burrow
985-81	AL	14H-5, 85	124.25-124.26	133.58-133.59	1						

Notes: Labels occurring in the "correlative samples" column are possible correlative samples of other holes established by comparing corrected depths (mcd). * = see "Explanatory Notes" chapter in Jansen, Raymo, Blum, et al. (1996). Type: AL = discrete ash layer, DA = disseminated ash layer, EL = ash-enriched layer. With a few corrections and additions during sampling at the Bremen Core Repository, depth intervals, thicknesses, stratigraphy, and colors are taken from Jansen, Raymo, Blum, et al. (1996). Relative abundance: * = rare, ** = common, *** = abundant; alt = altered, p.alt. = partly altered. Glass types: v = vesicular shards, bw = bubble-wall shards, p = pumice fragments, bl = blocky shards (in order of relative amount). Italic entries indicate geochemically analyzed samples.

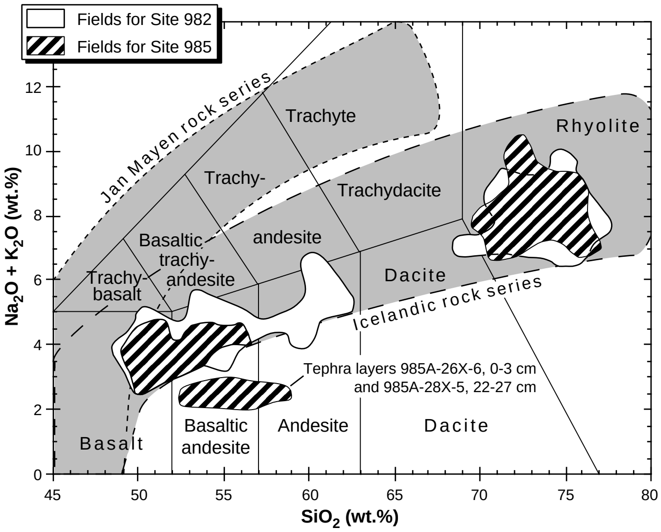

Figure 3. Classification of lower Pliocene and Miocene glasses recovered at Sites 982 and 985 based on total alkali-silica plot (after Le Bas et al., 1986). Fields for Jan Mayen rock series (Imsland, 1984) and for Icelandic rock series (Jakobsson, 1979) are shown for comparison. All analyses were normalized to a volatile-free total of 100%.

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Table 4. Electron microprobe analyses of glasses for Holes 982A (lower Pliocene–upper Miocene sequence), 982B (lower Pliocene–lower Miocene? sequence), and 982C (upper Miocene sequence).

Sample:	162-982A-16H-6		162-982A-18H-2		162-982A-24H-2		162-982B-14H-CC		162-982B-15H-3	
Interval (cm):	4-6		90-92		75-77		13-25		129-130	
Layer:	982-1*		982-2		982-3		982-5		982-6	
Remarks:										
Type:	DA?		AL?		DA		AL		AL	
Part./points:	12f/28p		19f/43p		12f/23p		17f/53p		15f/39p	
	Average	SD	Average	SD	Average	SD	Average	SD	Average	SD
SiO_{22}	70.39	0.42	70.92	0.44	67.15	0.68	70.66	0.32	67.12	0.27
TiO_2	0.21	0.03	0.23	0.03	0.33	0.05	0.19	0.03	0.33	0.03
Al_2O_3	11.82	0.08	11.72	0.08	12.2	0.18	11.54	0.09	12.23	0.1
FeO*	2.7	0.09	2.54	0.08	3.83	0.31	2.52	0.07	4.36	0.1
MnO	0.1	0.03	0.1	0.04	0.15	0.04	0.08	0.04	0.17	0.04
MgO	0.01	0.01	0.1	0.01	0.1	0.03	0.01	0.01	0.02	0.01
CaO	1.19	0.06	1.38	0.05	1.46	0.19	0.32	0.03	1	0.03
Na_2O	4.11	0.1	3.94	0.09	5.26	0.11	4.25	0.14	4.83	0.14
K_2O	3.13	0.13	2.78	0.08	2.84	0.14	4.19	0.23	3.36	0.06
P_2O_5	0.03	0.02	0.05	0.02	0.06	0.02	0.02	0.02	0.04	0.02
Σ (vol. free)	93.69		93.77		93.38		93.78			
SO_2										
F	0.13	0.02	0.07	0.02	0.1	0.02	0.17	0.02	0.13	0.02
Cl	0.13	0.02	0.06	0.02	0.09	0.01	0.23	0.02	0.15	0.02
Total	93.96		93.90		93.58		94.18			

Table 4 (continued).

Sample:	162-982B-16H-2		162-982B-16H-2		162-982B-17H-3		162-982B-18H-6		162-982B-18H-6	
Interval (cm):	66-68		66-68		34-36		49-50		49-50	
Layer:	982-7*		982-7*		982-8		982-9*		982-9*	
Remarks:	1. fraction		2. fraction				Felsic fraction		Intermediate fr.	
Type:	DA		DA		AL		AL		AL	
Part./points:	9f/16p		4f/6p		10f/16p		ca. 14f/32p		10f/25p	
	Average	SD	Average	SD	Average	SD	Average	SD	Average	SD
SiO_2	69.67	0.44	65.93	0.79	70.14	0.3	71.11	0.37	56.47	3.83
TiO_2	0.26	0.03	0.46	0.06	0.2	0.03	0.24	0.03	2.47	0.4
Al_2O_3	11.47	0.09	12.13	0.08	11.41	0.12	11.67	0.09	13.21	0.29
FeO*	3.45	0.15	5.4	0.55	2.71	0.08	2.6	0.09	10.68	1.69
MnO	0.14	0.03	0.2	0.03	0.11	0.03	0.11	0.03	0.21	0.05
MgO	0.09	0.02	0.23	0.04	0.01	0.01	0.1	0.03	3.39	0.88
CaO	1.87	0.14	2.87	0.3	1.2	0.04	1.36	0.11	7.18	1.24
Na_2O	4.38	0.08	4.37	0.14	4.56	0.17	4.47	0.1	3.02	0.36
K_2O	2.75	0.04	2.34	0.11	3.21	0.21	2.77	0.08	1.29	0.33
P_2O_5	0.06	0.03	0.11	0.02	0.03	0.02	0.04	0.02	0.36	0.07
Σ (vol. free)	94.14		94.04		93.58		94.47		98.27	
SO_2									0.1	0.05
F	0.07	0.02	0.09	0.02	0.12	0.03	0.07	0.02	0.14	0.04
Cl	0.08	0.02	0.06	0.03	0.14	0.02	0.05	0.02	0.03	0.02
Total	94.29		94.20		93.84		94.54		98.55	

Table 4 (continued).

Sample:	162-982B-28X-1		162-982B-29X-3		162-982B-32X-4		162-982B-32X-4		162-982B-40X-2	
Interval (cm):	91-93		69-71		10-12		10-12		2-5	
Layer:	982-10*		982-11		982-12*		982-12*		982-13*	
Remarks:			(rel. hetero.)		Felsic fraction		Mafic fraction		(rel. hetero.)	
Type:	AL		AL		DA		DA		DA	
Part./points:	13f/39p		15f/22p		12f/29p		6f/17p		12f/63p	
	Average	SD	Average	SD	Average	SD	Average	SD	Average	SD
SiO_2	70.58	0.5	69.23	0.8	66.89	0.46	48.93	0.38	51.33	0.78
TiO_2	0.21	0.03	0.2	0.04	0.37	0.02	3.77	0.11	3.16	0.2
Al_2O_3	10.73	0.12	12.51	0.19	11.35	0.17	12.88	0.14	13	0.1
FeO*	2.37	0.11	2.2	0.21	3.37	0.08	13.23	0.29	13.68	0.32
MnO	0.08	0.04	0.07	0.03	0.14	0.04	0.24	0.05	0.23	0.04
MgO	0.02	0.01	0.13	0.03	0.2	0.02	5.02	0.1	4.74	0.18
CaO	1.11	0.08	0.91	0.1	1.56	0.08	9.2	0.12	9.17	0.3
Na_2O	4.21	0.13	4.63	0.21	4.49	0.11	2.99	0.16	2.91	0.13
K_2O	2.97	0.15	3.89	0.17	2.74	0.09	0.75	0.04	0.65	0.06
P_2O_5	0.02	0.02	0.05	0.02	0.06	0.02	0.63	0.09	0.37	0.04
Σ (vol. free)	92.31		93.81		91.18		97.63		99.22	
SO_2							0.11	0.07	0.1	0.05
F	0.1	0.02	0.09	0.03	0.07	0.02	0.16	0.04	0.12	0.04
Cl	0.07	0.02	0.13	0.02	0.07	0.02	0.04	0.01	0.03	0.02
Total	92.48		94.03		91.33		97.94		99.48	

Table 4 (continued).

Sample:	162-982B-43X-2		162-982B-43X-2		162-982B-43X-2		162-982B-52X-4		162-982B-52X-4	
Interval (cm):	84-86		84-86		84-86		108-110		108-110	
Layer:	982-14		982-14		982-14		982-15*		982-15*	
Remarks:	1. felsic fraction		2. felsic fraction		Mafic fr. (hetero.)		Felsic fraction		Mafic fraction	
Type:	AL		AL		AL		AL		AL	
Part./points:	7f/11p		3f/6p		10f/28p		13f/40p		11f/41p	
	Average	SD	Average	SD	Average	SD	Average	SD	Average	SD
SiO_2	71.2	0.39	67.8	0.48	51.83	1.04	67.71	0.41	50.67	0.64
TiO_2	0.23	0.03	0.35	0.03	2.94	0.21	0.36	0.03	3.18	0.11
Al_2O_3	11	0.14	11.56	0.16	13.44	0.32	11.08	0.1	13.07	0.14
FeO*	2.4	0.21	4.33	0.09	12.98	0.6	4.03	0.12	14.01	0.3
MnO	0.07	0.03	0.15	0.06	0.24	0.04	0.16	0.04	0.26	0.05
MgO	0.01	0.01	0.15	0.02	4.25	0.36	0.16	0.02	4.75	0.26
CaO	1.02	0.08	2.06	0.05	8.38	0.43	1.89	0.06	8.98	0.33
Na_2O	4.36	0.18	4.65	0.22	2.96	0.26	4.71	0.11	2.9	0.18
K_2O	2.86	0.33	1.96	0.11	0.69	0.06	1.94	0.09	0.54	0.04
P_2O_5	0.03	0.02	0.09	0.02	0.65	0.13	0.07	0.02	0.38	0.04
Σ (vol. free)	93.20		93.10		98.37		92.12		98.73	
SO_2					0.06	0.04			0.07	0.04
F	0.08	0.02	0.07	0.03	0.14	0.04	0.07	0.02	0.13	0.04
Cl	0.05	0.02	0.04	0.02	0.02	0.02	0.04	0.01	0.01	0.01
Total	93.32		93.21		98.59		92.23		98.95	

Table 4 (continued).

Sample:	162-982B-55X-3		162-982B-56X-6		162-982C-15H-1		162-982C-15H-1			
Interval (cm):	54-56		56-58		137-139		137-139			
Layer:	982-17*		982-18*		982-19*		982-19*			
Remarks:	(rel. hetero.)				Felsic fraction		Mafic fraction			
Type:	AL		?		AL		AL			
Part./points:	7f/26p		8f/10p		14f/39p		5f/15p			
	Average	SD	Average	SD	Average	SD	Average	SD	Average	SD
SiO_2	49.66	0.3	67.73	0.33	69.89	0.34	50.45	0.55		
TiO_2	2.63	0.15	0.35	0.04	0.18	0.02	3.21	0.2		
Al_2O_3	13.41	0.12	11.87	0.08	11.02	0.14	14.07	0.22		
FeO*	12.5	0.2	3.26	0.13	2.56	0.07	12.98	0.56		
MnO	0.23	0.04	0.14	0.06	0.08	0.05	0.26	0.05		
MgO	6.32	0.12	0.2	0.01	0.02	0.01	4.31	0.17		
CaO	11.25	0.13	1.57	0.09	0.31	0.03	8.82	0.2		
Na_2O	2.61	0.18	4.38	0.27	4.75	0.17	3.34	0.26		
K_2O	0.36	0.03	2.83	0.17	4.25	0.2	1.09	0.06		
P_2O_5	0.31	0.03	0.06	0.02	0.02	0.01	0.97	0.06		
Σ (vol. free)	99.28		92.39		93.08		99.5			
SO_2	0.06	0.03					0.16	0.04		
F	0.11	0.04	0.09	0.03	0.18	0.03	0.21	0.04		
Cl	0.02	0.02	0.07	0.02	0.22	0.02	0.06	0.03		
Total	99.48		92.54		93.47		99.92			

Table 4 (continued).

Sample:	162-982C-17H-4		162-982C-17H-4		162-982C-19H-1		162-982C-19H-1		162-982C-27H-6	
Interval (cm):	124-126		124-126		7-9		7-9		128-130	
Layer:	982-20		982-20		982-21*		982-21*		982-22	
Remarks:	Felsic fraction		Mafic fraction		Felsic fraction		Mafic fr. (hetero.)			
Type:	AL		AL		AL-DA		AL-DA		AL	
Part./points:	ca. 14f/32p		12f/54p		14f/37p		9f/23p		14f/27p	
	Average	SD	Average	SD	Average	SD	Average	SD	Average	SD
SiO_2	70.08	0.5	51.73	1.16	70.57	0.25	50.13	1.54	71.26	0.32
TiO_2	0.21	0.03	3.32	0.33	0.22	0.03	3.52	0.34	0.2	0.03
Al_2O_3	11.63	0.16	12.71	0.09	11.47	0.12	13.17	0.24	10.87	0.1
FeO*	2.74	0.09	14.08	0.29	2.54	0.09	13.8	0.59	2.39	0.09
MnO	0.11	0.04	0.27	0.03	0.11	0.04	0.28	0.04	0.11	0.03
MgO	0.01	0.02	3.88	0.48	0.1	0.01	4.33	0.48	0.03	0.01
CaO	1.12	0.04	7.91	0.5	1.37	0.07	8.71	0.66	1.06	0.07
Na_2O	4.59	0.18	3.1	0.13	4.7	0.13	3.25	0.18	4.38	0.08
K_2O	3.21	0.2	0.82	0.11	2.79	0.09	0.75	0.14	2.92	0.15
P_2O_5	0.03	0.02	0.58	0.1	0.04	0.02	0.53	0.09	0.04	0.02
Σ (vol. free)	93.72		98.41		93.91		98.46		93.26	
SO_2			0.21	0.05			0.2	0.05		
F	0.13	0.03	0.16	0.04	0.07	0.02	0.13	0.05	0.1	0.03
Cl	0.15	0.05	0.03	0.01	0.06	0.02	0.06	0.03	0.07	0.01
Total	94		98.81		94.03		98.85		93.43	

Notes: * = layer that contains one to three glass fragments with differing chemical compositions (not listed here). Type abbreviations: AL = discrete ash layer, DA = disseminated ash layer, EL = ash-enriched layer. Part./points = number of analyzed particles (f) and total number of analyses (p). SD = standard deviation (2σ). Remarks abbreviations: fr. = fraction; rel. = relatively; hetero. = layer that contains chemically heterogeneous glass fragments. FeO* = total Fe as (FeO + Fe_2O_3).

Table 5. Electron microprobe analyses of glasses for Holes 985A (lower Pliocene–middle Miocene? sequence) and 985B (lower Pliocene–upper Miocene sequence).

Sample:	162-985A-11H-3		162-985A-11H-3		162-985A-12H-5		162-985A-16H-2	
Interval (cm):	55-56		34-35		109-111		88-90	
Layer:	**985-1t**		**985-1b**		**985-8**		**985-16**	
Remarks:	Top of the layer		Base of the layer					
Type:	AL		AL		AL		AL	
Part./points:	11f/20p		13f/28p		17f/39p		9f/23p	
	Average	SD	Average	SD	Average	SD	Average	SD
SiO_2	70.02	0.26	69.93	0.60	68.51	0.39	70.39	0.33
TiO_2	0.25	0.03	0.25	0.02	0.24	0.03	0.07	0.02
Al_2O_3	11.65	0.10	11.61	0.11	12.63	0.07	11.95	0.11
FeO*	2.85	0.08	2.76	0.21	2.45	0.08	1.17	0.07
MnO	0.11	0.03	0.11	0.03	0.09	0.03	0.06	0.03
MgO	0.02	0.02	0.02	0.01	0.17	0.02	0.03	0.01
CaO	1.25	0.05	1.24	0.12	0.72	0.03	0.54	0.02
Na_2O	4.90	0.14	4.90	0.12	4.98	0.10	4.12	0.11
K_2O	2.81	0.08	2.87	0.09	3.66	0.09	4.06	0.13
P_2O_5	0.04	0.03	0.04	0.02	0.04	0.02	0.02	0.02
Σ(vol.-free)	93.92		93.73		93.50		92.41	
SO_2								
F	0.12	0.02	0.12	0.02	0.15	0.03	0.09	0.02
Cl	0.09	0.02	0.09	0.02	0.19	0.02	0.14	0.02
Total	94.12		93.95		93.84		92.64	

Table 5 (continued).

Sample:	162-985A-21X-4		162-985A-21X-4		162-985A-23X-11		162-985A-23X-11		162-985A-26X-4	
Interval (cm):	65-67		65-67		12-14		12-14		52-54	
Layer:	**985-20***		**985-20***		**985-21**		**985-21**		**985-24**	
Remarks:	Felsic fraction		Mafic fr. (hetero.)		Felsic end-member		Mafic fr. (hetero.)			
Type:	AL		AL		AL		AL		AL	
Part./points:	9f/26p		9f/23p		14f/49p		12f/50p		12f/35p	
	Average	SD	Average	SD	Average	SD	Average	SD	Average	SD
SiO_2	70.76	0.45	52.58	1.01	71.15	0.58	51.66	1.75	67.68	0.34
TiO_2	0.26	0.03	3.07	0.30	0.25	0.04	3.45	0.42	0.28	0.03
Al_2O_3	11.17	0.15	12.96	0.28	11.43	0.14	13.34	0.22	12.09	0.09
FeO*	3.08	0.19	13.30	0.62	3.03	0.20	13.72	0.86	3.77	0.14
MnO	0.11	0.04	0.25	0.04	0.13	0.05	0.26	0.04	0.18	0.03
MgO	0.01	0.01	3.92	0.52	0.11	0.02	4.50	0.52	0.06	0.01
CaO	1.33	0.11	7.66	0.45	1.05	0.09	8.53	0.63	0.87	0.04
Na_2O	4.17	0.17	3.10	0.11	4.64	0.05	2.77	0.38	5.03	0.12
K_2O	2.52	0.14	0.86	0.11	1.74	0.09	0.60	0.12	2.82	0.10
P_2O_5	0.04	0.02	0.63	0.15	0.05	0.02	0.51	0.17	0.04	0.03
Σ (vol.-free)	93.46		98.34		93.57		99.33		92.83	
SO_2			0.16	0.09			0.08	0.06		
F	0.08	0.02	0.15	0.04	0.07	0.03	0.14	0.04	0.10	0.02
Cl	0.05	0.02	0.02	0.01	0.04	0.01	0.02	0.01	0.09	0.02
Total	93.59		98.67		93.68		99.56		93.02	

Table 5 (continued).

Sample:	162-985A-26X-6		162-985A-26X-6		162-985A-26X-6		162-985A-26X-6		162-985A-28X-3	
Interval (cm):	0-2		55-57		55-57		55-57		74-76	
Layer:	**985-25***		**985-26**		**985-26**		**985-26**		**985-27**	
Remarks:			Felsic end-member		Intermediate fr.		Mafic end-member			
Type:	AL		AL		AL		AL		DA/EL	
Part./points:	12f/40p		14f/25p		14f/43p		3f/10p		7f/10p	
	Average	SD	Average	SD	Average	SD	Average	SD	Average	SD
SiO_2	51.79	0.95	66.81	0.32	53.49	1.49	49.58	0.21	67.85	0.76
TiO_2	2.79	0.21	0.48	0.05	2.53	0.45	2.60	0.10	0.23	0.03
Al_2O_3	13.42	0.14	11.97	0.15	13.78	0.23	13.44	0.08	11.64	0.09
FeO*	13.46	0.35	4.73	0.19	12.98	0.60	13.74	0.21	3.46	0.11
MnO	0.30	0.04	0.15	0.03	0.29	0.05	0.25	0.06	0.12	0.04
MgO	3.58	0.26	0.31	0.04	3.40	0.50	5.78	0.11	0.04	0.01
CaO	7.84	0.25	2.23	0.11	7.46	0.48	10.17	0.14	1.23	0.05
Na_2O	1.49	0.11	4.50	0.12	3.30	0.16	2.78	0.10	4.19	0.27
K_2O	0.79	0.05	1.91	0.04	0.82	0.10	0.39	0.02	3.43	0.11
P_2O_5	1.20	0.08	0.11	0.02	1.06	0.18	0.32	0.03	0.06	0.03
Σ (vol.-free)	96.67		93.19		99.12		99.04		92.26	
SO_2	0.14	0.05			0.25	0.05	0.10	0.03		
F	0.19	0.04	0.07	0.02	0.16	0.04	0.10	0.04	0.08	0.03
Cl	0.04	0.02	0.06	0.01	0.04	0.03	0.02	0.01	0.11	0.02
Total	97.03		93.31		99.58		99.26		92.45	

Table 5 (continued).

Sample:	162-985A-28X-5		162-985A-29X-5		162-985A-30X-3		162-985B-11H-5		162-985B-11H-5	
Interval (cm):	23-25		146-148		115-117		91-92		110-111	
Layer:	**985-28**		**985-29**		**985-31***		**985-46t**		**985-46b**	
Remarks:	Heterogeneous						Top of the layer		Base of the layer	
Type:	AL		?		AL		AL		AL	
Part./points:	16f/64p		17f/23p		11f/54p		16f/34p		13f/30p	
	Average	SD	Average	SD	Average	SD	Average	SD	Average	SD
SiO_2	52.64	1.12	68.17	0.45	49.30	0.43	70.22	0.20	70.37	0.30
TiO_2	2.22	0.17	0.28	0.03	3.28	0.23	0.27	0.02	0.26	0.03
Al_2O_3	13.78	0.48	11.79	0.12	13.37	0.29	11.76	0.09	11.78	0.06
FeO*	11.72	0.58	3.52	0.17	13.55	0.42	2.83	0.10	2.89	0.11
MnO	0.24	0.05	0.15	0.04	0.25	0.05	0.12	0.02	0.13	0.04
MgO	3.47	0.59	0.01	0.01	4.61	0.29	0.03	0.01	0.02	0.01
CaO	7.63	0.60	0.89	0.10	8.98	0.36	1.28	0.04	1.29	0.05
Na_2O	1.38	0.22	4.48	0.17	3.12	0.17	4.70	0.07	4.67	0.09
K_2O	1.03	0.09	3.72	0.11	0.89	0.09	2.88	0.04	2.88	0.09
P_2O_5	0.43	0.16	0.04	0.02	0.55	0.10	0.04	0.02	0.02	0.02
Σ(vol.-free)	94.55		93.04		97.89		94.12		94.31	
SO_2	0.04	0.03			0.12	0.06				
F	0.14	0.04	0.12	0.03	0.16	0.03	0.12	0.02	0.11	0.02
Cl	0.04	0.02	0.18	0.02	0.04	0.02	0.09	0.02	0.09	0.02
Total	94.78		93.34		98.21		94.33		94.51	

Table 5 (continued).

Sample:	162-985B-13H-2		162-985B-13H-3	
Interval (cm):	129-131		150-152	
Layer:	**985-75**		**985-78**	
Remarks:				
Type:	AL		AL	
Part./points:	16f/24p		9f/25p	
	Average	SD	Average	SD
SiO_2	67.91	0.35	69.64	0.44
TiO_2	0.21	0.02	0.25	0.03
Al_2O_3	11.98	0.19	12.72	0.10
FeO*	3.45	0.14	1.71	0.08
MnO	0.13	0.04	0.05	0.03
MgO	0.02	0.01	0.22	0.01
CaO	0.55	0.09	0.90	0.05
Na_2O	5.28	0.12	4.28	0.10
K_2O	4.07	0.11	4.28	0.10
P_2O_5	0.03	0.02	0.05	0.02
Σ (vol.-free)	93.64		94.11	
SO_2				
F	0.14	0.02	0.07	0.02
Cl	0.17	0.02	0.15	0.02
Total	93.94		94.33	

Notes: * = layer that contains one to three glass fragments with differing chemical compositions (not listed here). Type abbreviations: AL = discrete ash layer, DA = disseminated ash layer, EL = ash-enriched layer. Part./points = number of analyzed particles (f) and total number of analyses (p). SD = standard deviation (2σ). Remarks abbreviations: fr. = fraction; rel. = relatively; hetero. = layer that contains chemically heterogeneous glass fragments. FeO* = total Fe as (FeO + Fe_2O_3).

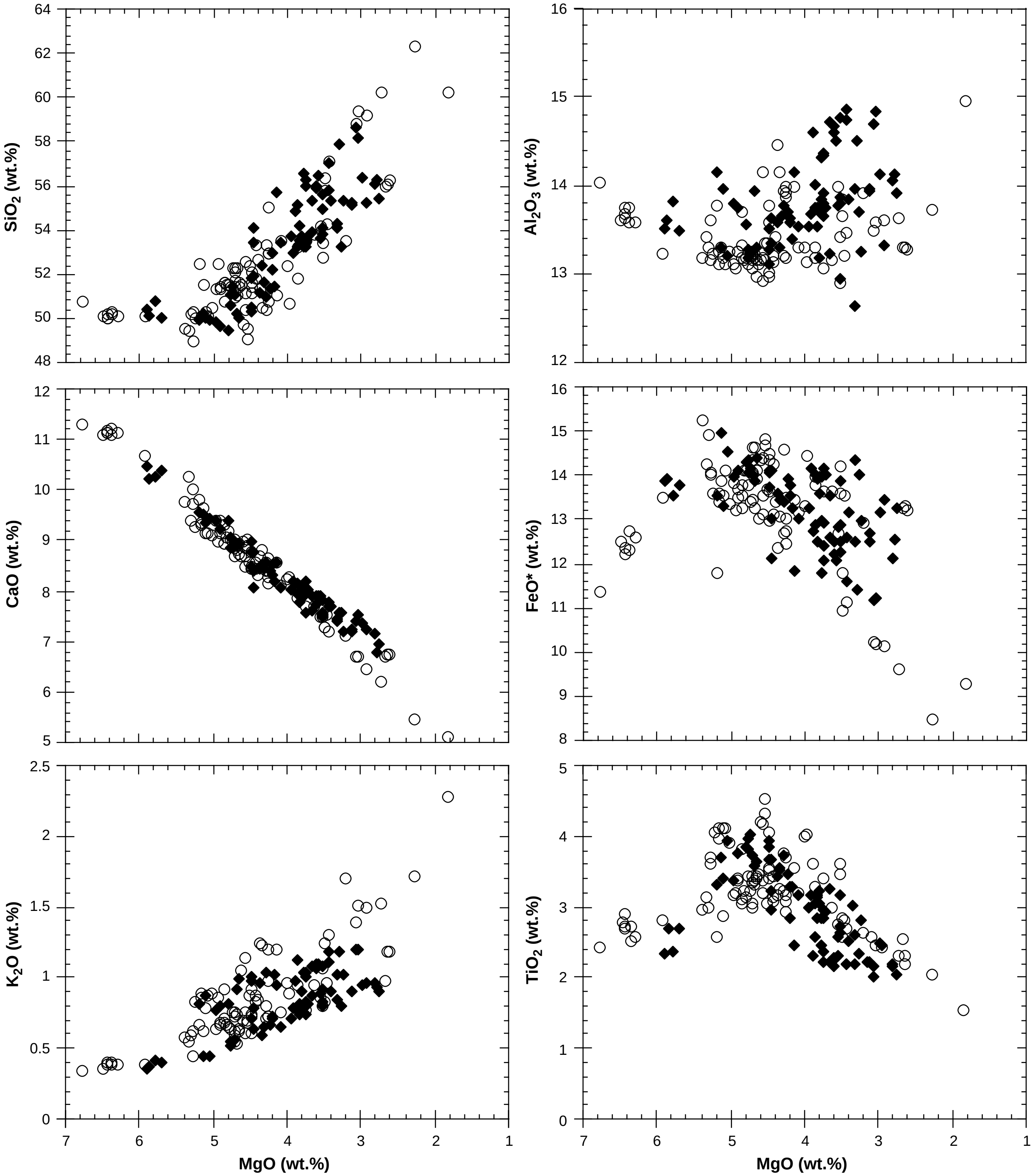

Figure 4. MgO variation diagrams showing the major-element compositions (SiO_2, Al_2O_3, CaO, FeO*, K_2O, and TiO_2) of mafic and intermediate glass particles recovered at Sites 982 (open circles) and 985 (solid diamonds). All analyses were normalized to a volatile-free total of 100%.

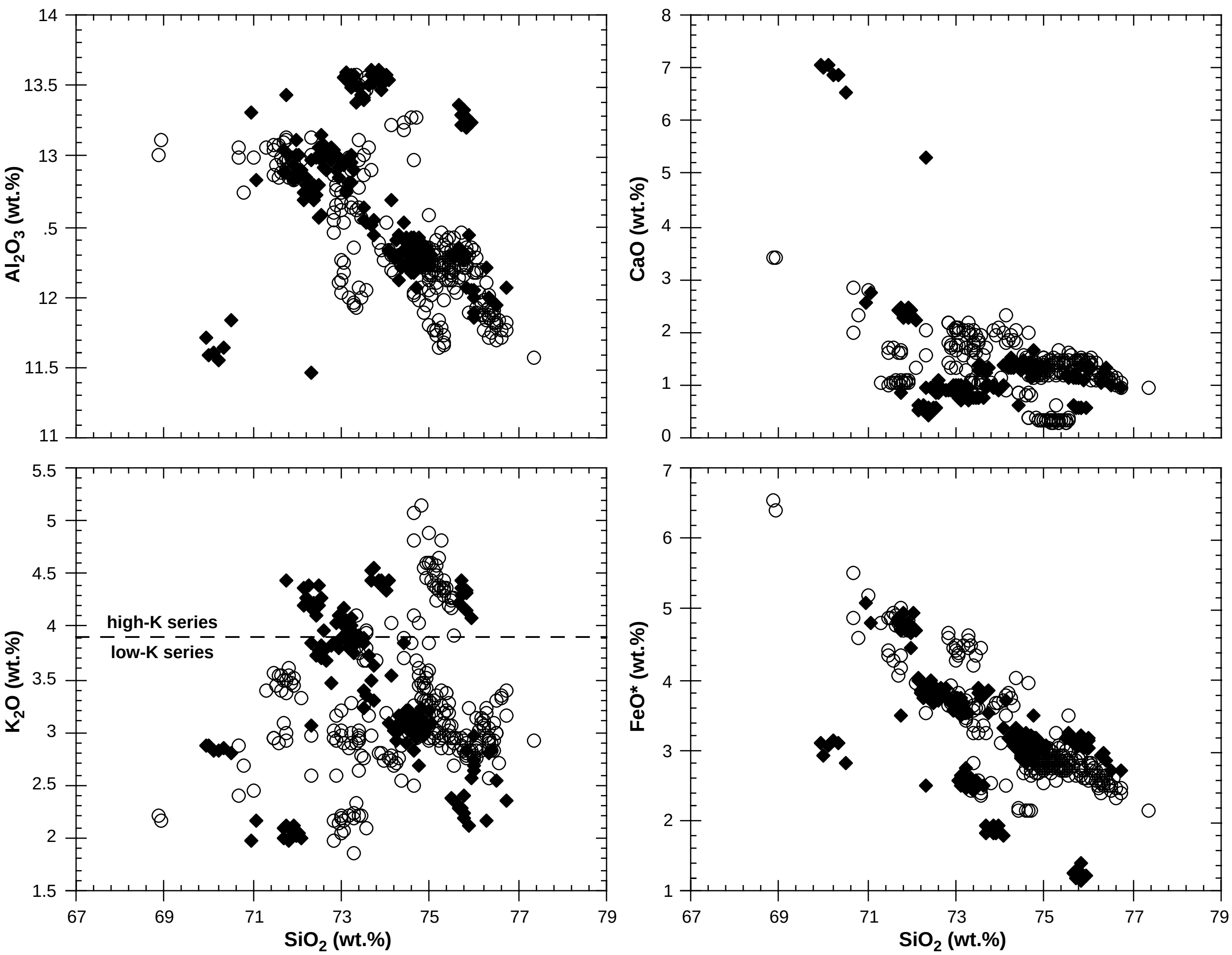

Figure 5. SiO_2 variation diagrams showing the major-element compositions (Al_2O_3, CaO, K_2O, and FeO*) and subdivision into low-K and high-K series (after Sigurdsson and Loebner, 1981) of rhyolitic glass particles recovered at Sites 982 (open circles) and 985 (solid diamonds). All analyses were normalized to a volatile-free total of 100%.

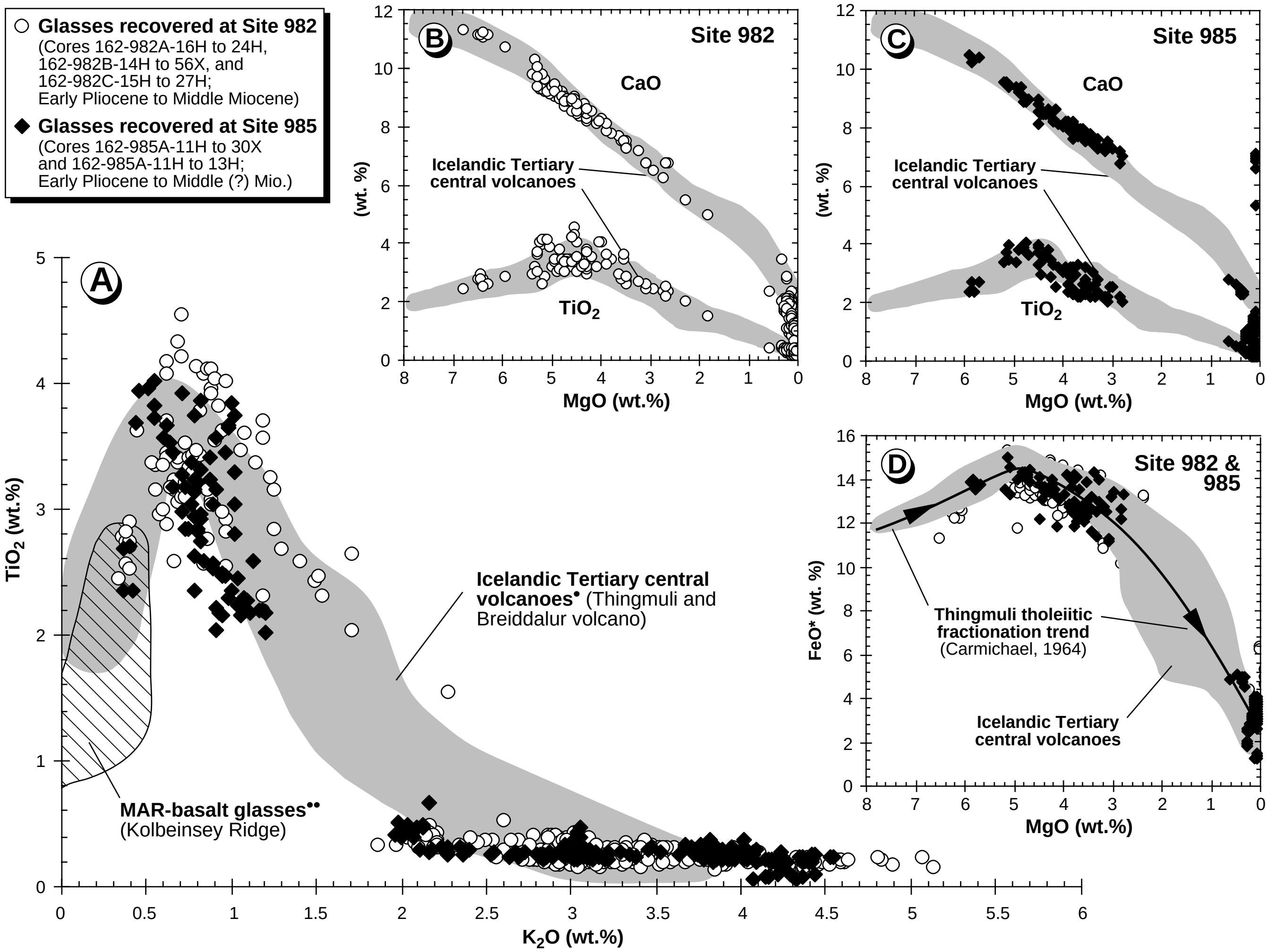

Figure 6. Selected major-element concentrations of rhyolitic, intermediate, and mafic glass particles recovered at Sites 982 and 985 (lower Pliocene and Miocene sequence) and reference fields for Tertiary Icelandic central volcanoes (• = whole-rock analyses by Walker, 1963, and Carmichael, 1964) and Kolbeinsey Ridge basalts (•• = glass analyses by Lackschewitz and Wallrabe-Adams, 1991, and Lackschewitz et al., 1994). All analyses were normalized to a volatile-free total of 100%. **A.** TiO_2 vs. K_2O concentrations. **B.** CaO and TiO_2 vs. MgO concentrations (Site 982). **C.** CaO and TiO_2 vs. MgO concentrations (Site 985). **D.** FeO* vs. MgO concentrations.

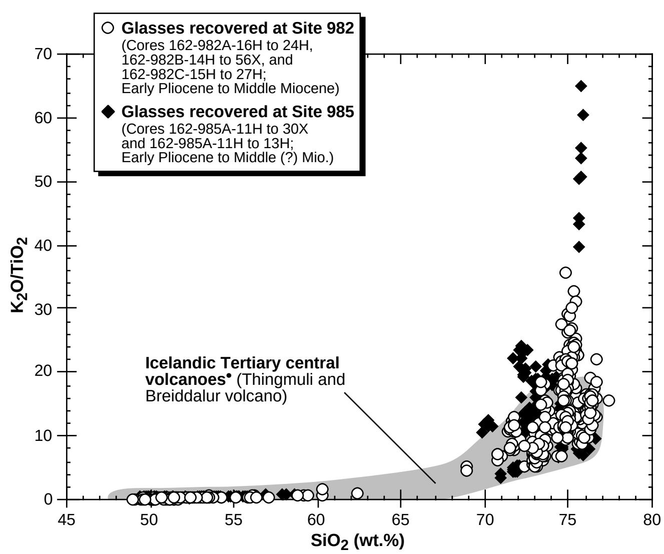

Figure 7. K_2O/TiO_2 vs. SiO_2 concentrations of rhyolitic, intermediate, and mafic glass particles recovered at Sites 982 and 985 (lower Pliocene and Miocene sequence) and reference fields for Tertiary Icelandic central volcanoes (• = whole-rock analyses by Walker, 1963, and Carmichael, 1964).