13. PETROLOGY OF BASALTS FROM DEEP SEA DRILLING PROJECT, LEG 38

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INTRODUCTION

We have determined the bulk composition of basalt samples drilled during Leg 38. These data provide a basis for discussion of trace element abundances, Sr isotopic compositions, and mineral chemistry. Basaltic basement was collected at Sites 336, 337, 338, 342, 344, 345, 348, 350. Most of the basalts examined have textures that indicate rapid cooling, evidenced by the presence of glass and skeletal-shaped olivine and plagioclase grains. Samples from Site 336 are fine-grained, subophitic basalts with microphenocrysts of plagioclase and olivine. Variolitic, amygdaloidal basalt occurs at Site 337 containing sparse phenocrysts of altered olivine. Basalt at Site 338 is uniformly subophitic with occasional phenocrysts. At least two textural varieties were observed at Site 342: an upper basalt with subophitic to holocrystalline texture, and a lower basalt with a coarse diabase texture. This texture also characterizes the diabase samples examined from Site 344. Fine-grained basalts from Site 345 are highly altered compared to fresher, aphyric samples from Sites 348 and 350.

MAJOR ELEMENT CHEMISTRY

Major elements were determined on fused glass samples by electron microprobe. Fe_2O_3 values were computed so that $Fe_2O_3 = 0.1 \times$ total iron as FeO. Analyses are computed on an H_2O-free basis. Two basalts (GAST, KNIPPA) were run as secondary standards during the analysis of the Leg 38 samples. Data are shown in Table 1.

Basalts at Site 336 are quartz tholeiites with low TiO_2, K_2O, and Mg/Mg+Fe (Mg*) ratios of 48. Chemically similar basalts were analyzed from Site 337, except for slightly higher Al_2O_3 values (15%-16%) and higher Mg* ratios (55). Plagioclase tholeiites occur at Site 338 with greater than 16% Al_2O_3, low total FeO, and high Mg* ratios (59-63). In contrast, samples from Site 342 are more alkalic, with 3% TiO_2, somewhat higher K_2O, low total FeO and low, but variable, Mg* ratios (45-55). Chemically similar basalt occurs at Site 343. The diabase samples at Site 344 are titania-poor olivine tholeiites, but are enriched in K_2O relative to tholeiites from other sites. K_2O enrichment may be due to deuteric alteration. These diabase samples also have high Mg* ratios. One sample (344-34-2) is extremely enriched in FeO and TiO_2, with a lesser enrichment in K_2O and depletion in MgO. We interpret this as a strongly fractionated facies of the diabase. Two samples from Site 345 are tholeiites with above average MgO values and high Mg* ratios (64-70). Typical low-titania tholeiites were analyzed from Sites 348 and 350 with Mg* ratios between 45-51.

The overall sample population contains both quartz tholeiites and olivine tholeiites; the latter are close to being silica oversaturated. Samples from Sites 336, 337, 338, 345, 350 have bulk compositions similar to many other oceanic tholeiites, and their variations in Al_2O_3, K_2O, and Mg* ratio probably reflect minor removal or addition of plagioclase and olivine together with the effects of halmyrolysis. However, those samples with high Mg* ratios (338, 344, 345) show no signs of excess olivine and appear to be the most primitive basalts sampled. Several samples are titania rich, but are essentially tholeiites rather than alkalic basalts. These samples also have the lowest Mg* ratios, low MgO, and high K_2O and may represent basalt magmas that have undergone low pressure fractionation.

TRACE ELEMENT CHEMISTRY

The abundance of Rb, Sr, Zr, and Y were determined by X-ray fluorescence techniques and are shown in Table 2. Tholeiites from Sites 336, 337, and 338 have 1-5 ppm Rb, which, together with low K_2O contents, suggests that halmyrolysis has had little effect on basalts at these sites. Y contents (22-34 ppm) and Zr (50-82 ppm) are uniformly low, and together with the low Sr values for Site 336 and 337 basalts confirm that these samples are typical oceanic tholeiites. The Sr and Al_2O_3 contents of samples from Site 338 may result from minor plagioclase accumulation.

Samples from Site 342 show 2-3-fold enrichment in Zr and 1.5-2-fold enrichment in Sr over typical oceanic tholeiites, but Rb and Y are not strikingly enriched. Higher than normal Zr was also observed in Site 343 basalt, but Rb remained low. Diabases at Site 344 show marked enrichment in Rb (10-34 ppm), but this is not accompanied by enrichment in Zr (84-94 ppm) or Y (21-27 ppm), although Sr values are rather high (196-225 ppm).

High Rb and Sr contents also characterize Site 345 samples, but Y remains low (26 ppm) and Zr is variable but not exceptionally high. The trace element composition of Site 348 basalts are typical of oceanic tholeiites; Rb is low (1 ppm) as are Sr (88-98 ppm) and Zr (64-72 ppm), whereas Y is more varied (34-41 ppm). At Site 350, trace element contents show no internal consistency, low Rb (4 ppm) and Y (37 ppm) are associated with high Zr (158 ppm) and Sr (250 ppm).

Generally the behavior of the lithophile (LIL) trace elements is consistent with the bulk chemistry in that samples designated as typical oceanic tholeiites show appropriate low concentrations of LIL elements. In contrast, those samples with high TiO_2 contents show consistently high concentrations of Zr and Y and, in some cases, Sr. Even under the most favorable conditions of fractional crystallization, inspection of the

TABLE 1
Major Element Composition and CIPW Norms of Leg 38 Samples

	Site (Core-Section)																				
	336		337			338			342			343	344			345		348		350
	41-1	42-1	13-2	14-2	15-2	43-2	43-4	45-2	7-2	7-5	8-2	13-2	34-2	35-4	37-2	33-2	35-1	32-4	34-2	16-2
SiO_2	50.08	50.57	49.87	50.55	50.19	49.08	48.62	51.00	48.90	49.48	50.08	49.73	47.21	51.58	50.58	51.20	51.10	48.93	48.99	50.86
TiO_2	1.68	1.62	1.48	1.36	1.31	1.38	1.46	1.52	2.80	3.18	3.18	3.05	3.52	1.46	1.37	1.83	2.11	1.60	1.51	2.67
Al_2O_3	13.95	14.22	15.94	15.45	15.11	16.83	16.69	16.52	15.42	15.22	14.81	14.02	14.10	15.98	17.46	17.80	18.38	15.34	14.87	14.21
Fe_2O_3	1.34	1.32	1.07	1.08	1.06	0.98	1.04	0.84	1.16	1.22	1.20	1.34	1.89	0.80	0.72	1.01	0.87	1.45	1.40	1.40
FeO	10.86	10.69	8.66	8.77	8.61	7.93	8.46	6.87	9.45	9.94	9.73	10.83	15.38	6.51	5.83	8.17	7.01	11.75	11.38	11.41
MnO	0.26	0.19	0.23	0.20	0.16	0.19	0.18	0.15	0.25	0.16	0.17	0.19	0.31	0.18	0.12	0.22	0.22	0.21	0.20	0.22
MgO	6.40	6.17	6.61	6.69	6.70	7.37	7.57	7.45	7.24	5.17	5.11	5.69	6.65	7.69	7.00	9.01	10.24	6.17	7.53	5.75
CaO	11.70	11.54	12.91	13.25	13.18	12.94	12.52	11.96	12.79	11.39	11.21	10.97	4.49	11.10	11.38	7.47	4.09	10.86	10.65	9.15
Na_2O	2.16	2.34	2.25	1.58	2.16	2.09	2.26	2.69	1.98	2.76	2.92	2.68	3.86	2.82	2.87	2.56	2.24	2.18	2.04	2.67
K_2O	0.10	0.09	0.11	0.10	0.08	0.13	0.10	0.10	0.15	0.31	0.38	0.23	0.51	0.47	0.26	0.73	0.28	0.11	0.13	0.22
Fe as FeO	12.07	11.88	9.62	9.74	9.56	8.81	9.40	7.63	10.50	11.04	10.81	12.03	17.08	7.23	6.47	9.08	7.80	13.06	12.64	12.67
$\frac{100\ Mg}{Mg + Fe}$	48.8	48.3	55.3	55.2	55.7	60.1	59.1	63.7	55.4	45.7	45.9	46.0	41.2	65.6	66.0	64.1	70.2	45.9	51.7	44.9
Fe_2O_3 = FeO × 0.1																				
QZ	1.46	1.61	0.00	3.22	0.49	0.00	0.00	0.00	0.00	0.63	0.92	1.08	0.00	0.00	0.00	0.00	8.84	0.00	0.00	3.27
OR	0.59	0.53	0.65	0.59	0.47	0.77	0.59	0.59	0.89	1.83	2.25	1.36	3.02	2.78	1.54	4.32	1.66	0.65	0.77	1.30
AB	18.28	19.80	18.96	13.37	18.28	17.69	19.12	22.76	16.75	23.36	24.71	22.68	32.66	23.86	24.29	21.66	18.96	18.45	17.26	22.59
AN	28.08	28.04	33.12	34.78	31.31	36.17	35.11	32.72	32.75	28.23	26.19	25.55	19.65	29.57	34.00	34.93	20.79	31.76	31.04	26.15
DI	24.83	24.22	25.40	25.44	27.98	22.87	22.06	21.59	25.22	23.37	24.30	28.89	2.20	20.64	18.15	1.73	.00	18.41	18.00	15.98
HY	20.17	19.56	15.70	17.49	16.01	13.02	9.84	16.21	15.08	13.61	12.65	16.43	14.00	16.34	13.99	30.51	34.58	23.86	24.68	22.17
OL	0.00	0.00	0.94	0.00	0.00	4.37	7.90	1.14	3.64	0.00	0.00	0.00	16.93	1.48	1.98	1.92	.00	0.34	2.05	0.00
MT	1.94	1.91	1.55	1.57	1.54	1.42	1.51	1.22	1.68	1.77	1.74	1.94	2.44	1.16	1.04	1.46	1.26	2.10	2.03	2.08
IL	3.19	3.08	2.81	2.58	2.49	2.62	2.77	2.89	2.81	6.04	6.04	5.79	6.69	2.77	2.60	3.48	4.01	3.04	2.87	5.07
CO																	6.96			

TABLE 2
Trace Element Abundances in Leg 38 Basalts

Sample (Interval in cm)	Rb	Sr	Y	Zr	Rb/Sr	Zr/Y
336-41-1	2.5	137	30	76	0.018	2.5
336-42-1, 144-146	1.0	144	35	82	0.007	2.3
337-13-2, 140-143	5	94	35	57	0.053	1.6
337-14-2, 91-94	5	96	34	55	0.053	1.5
337-15-2, 137-140	3.4	80	29	57	0.042	2.0
338-43-2, 115-118	3.3	167	23	62	0.019	2.7
338-43-4, 54-57	4.0	173	22	50	0.023	2.3
338-45-2, 56-59	1.5	151	27	64	0.010	2.4
342-7-2, 137-140	7.1	250	36	186	0.028	5.1
342-7-5, 126-129	7.8	241	42	180	0.032	4.3
342-8-2, 65-68	3.4	209	36	189	0.016	5.3
343-13-2, 20-23	5.1	202	40	154	0.025	3.9
344-34-2, 27-30	13.9	214	26	90	0.064	3.5
344-35-4, 87-90	34.1	196	22	84	0.173	3.8
344-37-2, 135-137	10.3	225	27	94	0.045	3.5
345-33-2, 56-59	15.3	256	26	94	0.059	3.6
345-35-1, 145-148	19.9	244	26	142	0.081	5.5
348-32-4, 93-96	1.6	98	41	72	0.016	1.8
348-34-2, 107-110	1.3	88	34	64	0.014	1.9
350-16-2, 30-33	3.8	251	38	158	0.015	4.1

trace element abundances and within the constraints afforded by the major element data, it would not be possible to derive the titania-rich and LIL element-rich basalts by fractional crystallization of a typical oceanic tholeiite. Rather, it seems that these magmas may be derivatives of a compositionally distinct (and unsampled) parent magma whose mantle source was chemically different from that of typical oceanic tholeiites.

MINERAL CHEMISTRY

We have determined the range of compositions of the major mineral phases in representative samples of each basalt type from each site. Mineral determinations utilized an ARL-EMX microprobe with appropriate application of instrumental and Bence-Albee matrix corrections. Data are tabulated in Table 3 (plagioclase), Table 4 (pyroxenes), and Table 5 (iron-titanium oxides). Few samples contained fresh olivine, and no useful data could be determined for this mineral.

Generally the minerals show a limited range of compositions as a consequence of relatively rapid cooling. As might be expected, the most extensive mineral zoning was measured from Site 342 and 344 samples which are coarser grained than samples from other sites. Variations in major end-member components of pyroxenes are shown in Figure 1. The pyroxenes are dominantly calcic diopsidic augites, no low-calcium pyroxenes were detected. The zoning trends result in depletion in the wollastonite component which is not invariably associated with iron enrichment. These trends are in contrast to the iron-enrichment trends at relatively constant wollastonite content observed for many volcanic and plutonic pyroxenes. It is also noted that some of the pyroxenes fall within the two-pyroxene field boundary as defined by the trend for calcium-rich pyroxenes from the Skaergaard intrusion. In the Leg 38 samples, it appears that relatively rapid cooling initiated rapid crystal growth and consequently metastable compositional trends developed. Significant deviations from stable crystallization are also indicated by the contents of minor elements Al, Ti, Cr. Rapidly cooled pyroxenes are highly aluminous and contrast

TABLE 3A
Plagioclase in Basalts at Site 338

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SiO_2	49.46	49.87	50.88	47.35	51.32	51.03	51.45	52.61	50.89	51.44	47.42	47.85	47.36	47.85	49.44	48.69
TiO_2	0.08	0.04	0.03	0.03	0.06	0.06	0.07	0.11	0.07	0.10	0.10	0.11	0.10	0.10	0.18	0.18
Al_2O_3	31.67	31.47	30.58	33.79	29.32	29.39	29.01	28.47	29.48	29.48	33.28	33.53	34.53	33.87	29.73	31.27
FeO	0.92	0.79	0.76	0.57	1.02	1.31	1.34	1.14	0.93	1.08	0.65	0.56	0.162	0.59	1.33	1.36
MnO	0.04	0.02	0.03	0.01	0.01	0.02	0.03	0.04	0.01	0.04	0.02	0.01	0.02	0.02	0.04	0.05
MgO	0.18	0.21	0.15	0.17	0.61	0.60	0.69	0.66	0.51	0.55	0.38	0.35	0.36	0.34	0.18	0.13
CaO	14.52	14.52	13.34	15.90	13.34	13.22	12.34	12.73	13.62	13.04	16.94	17.62	17.17	17.05	15.43	12.69
Na_2O	3.76	3.84	4.47	2.51	3.94	4.02	3.91	3.44	3.24	3.23	1.57	1.29	1.34	1.30	2.80	3.17
K_2O	0.04	0.04	0.06	0.02	0.03	0.06	0.10	0.06	0.04	0.10	0.01	0.02	0.02	0.01	0.08	0.31
Total	100.67	100.80	100.30	100.35	99.65	99.72	98.94	99.26	98.79	98.85	100.39	100.92	101.14	101.13	99.21	98.08
Si	2.256	2.270	2.320	2.167	2.352	2.344	2.371	2.408	2.348	2.368						
Ti	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.003	0.002	0.001						
Al	1.703	1.688	1.643	1.823	1.584	1.591	1.576	1.536	1.603	1.728						
Fe	0.035	0.030	0.028	0.021	0.039	0.043	0.052	0.003	0.035	0.022						
Mn	0.001	–	0.001	–	–	–	0.001	0.001	–	0.001						
Mg	0.012	0.014	0.009	0.011	0.041	0.040	0.047	0.045	0.035	0.038						
Ca	0.709	0.708	0.651	0.780	0.655	0.651	0.609	0.624	0.673	0.643						
Na	0.333	0.338	0.395	0.222	0.351	0.358	0.348	0.305	0.290	0.289						
K	0.002	0.002	0.003	0.001	0.002	0.003	0.006	0.003	0.002	0.006						
Al+Si	3.959	3.958	3.963	3.990	3.936	3.935	3.947	3.944	3.951	4.096						
An	70	70	65	78	65	65	62	64	68	67						
Mg/Fe	0.34	0.47	0.32	0.52	1.05	0.93	0.90	1.04	1.00	1.72						

Note: 1,2 = microlites; 3 = (edge), 4 = (core) phenocryst; 5-10 = microlites; 11-14 = weakly zoned phenocrysts; 15-16 = microlites.

TABLE 3B
Plagioclases in Basalts at Site 342

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
SiO_2	49.87	52.87	49.26	51.40	51.10	51.27	53.96	53.61	54.05	53.83	54.24	53.63	53.12	50.81	52.41	21.27	55.52	51.95
TiO_2	0.07	0.07	0.03	0.06	0.06	0.06	0.08	0.08	0.06	0.09	0.07	0.07	0.06	0.03	0.03	0.05	0.21	0.06
Al_2O_3	31.96	29.75	31.58	30.72	30.36	31.38	28.90	29.18	28.65	29.08	28.58	29.06	29.41	31.34	30.31	30.88	27.30	29.56
FeO	0.71	0.95	0.67	0.60	0.67	0.76	0.85	1.07	0.72	0.83	0.87	0.98	0.80	0.61	0.59	0.62	1.65	0.59
MnO	–	0.01	0.03	0.02	0.02	–	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.03	0.01	–	–
MgO	0.16	0.10	0.15	0.17	0.15	0.12	0.14	0.11	0.19	0.19	0.22	0.08	0.11	0.18	0.17	0.13	0.21	0.18
CaO	15.85	13.02	16.06	14.07	13.98	15.32	12.76	12.54	12.94	13.02	12.52	13.07	14.18	14.71	14.95	14.95	10.00	15.17
Na_2O	3.03	5.15	2.74	4.22	3.56	3.26	5.21	5.04	4.95	4.51	4.80	4 36	3.72	3.29	3.04	3.25	6.04	2.84
K_2O	0.40	0.75	0.42	0.42	0.45	0.43	0.56	0.56	0.48	0.44	0.50	0.65	0.43	0.36	0.31	0.32	0.86	0.31
Total	102.05	102.67	100.94	101.70	100.34	102.60	102.48	102.20	102.04	102.01	101.81	101.91	101.84	101.35	101.84	101.48	101.79	100.66
Si	2.249	2.364	2.247	2.317	1.219	2.294	2.409	2.399	2.419	2.406	2.430	2.410	2.384	2.295	2.349	2.312	2.488	2.376
Ti	0.002	0.002	–	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.007	0.002
Al	1.698	1.568	1.697	1.632	1.631	1.654	1.520	1.539	1.511	1.532	1.511	1.533	1.555	1.668	1.601	1.642	1.442	1.563
Fe	0.026	0.035	0.025	0.022	0.025	0.028	0.031	0.040	0.027	0.031	0.032	0.036	0.030	0.023	0.022	0.023	0.062	0.022
Mn	–	–	0.011	–	–	–	–	–	–	0.001	–	–	–	–	0.001	–	–	–
Mg	0.010	0.007	0.010	0.011	0.010	0.008	0.009	0.007	0.012	0.013	0.014	0.005	0.007	0.012	0.011	0.009	0.014	0.012
Ca	0.766	0.623	0.785	0.680	0.683	0.734	0.610	0.601	0.620	0.624	0.597	0.624	0.682	0.712	0.718	0.722	0.480	0.729
Na	0.265	0.447	0.242	0.369	0.314	0.283	0.451	0.437	0.430	0.400	0.415	0.377	0.323	0.288	0.265	0.284	0.525	0.249
K	0.023	0.043	0.024	0.024	0.026	0.024	0.031	0.032	0.027	0.025	0.028	0.037	0.024	0.020	0.017	0.018	0.049	0.017
Al + Si	3.947	3.932	3.944	3.949	3.960	3.948	3.929	3.938	3.930	3.938	3.941	3.943	3.939	3.963	3.950	3.954	3.930	3.939
An	75	60	77	66	68	73	59	60	61	62	59	62	68	71	71	72	48	72
Mg/Fe	0.38	0.20	0.40	0.50	0.40	0.28	0.29	0.17	0.44	0.4	0.43	0.14	0.23	0.52	0.50	0.39	0.22	0.54

Note: 1 = (core) phenocryst; 2-6 = zoned phenocryst; 7 = (core) phenocryst; 8 = (core) phenocryst; 9 = (core) phenocryst; 10, 11 = (core) phenocryst; 12 (edge)- 16 (core) = zoned phenocryst; 17 (edge) 19 (core) = phenocryst; 20 (edge), 21 (core) = phenocryst; 22 (edge)- 24 (core) = phenocryst; 25, 26 = (core) microphenocryst; 27 (edge)- 32 (core) = phenocryst; 32 (core)- 34 (edge) = phenocryst; 35 (core), 36 (edge) = phenocryst; 37, 38 = (core) phenocryst.

with the lower Al contents of more slowly cooled pyroxenes. Since the basalts show little variation in bulk Al_2O_3 content, and there is no obvious relationship between pyroxene minor element content and bulk composition, it can be concluded that the latter is not the dominant factor in determining pyroxene compositions.

A brief survey was made of plagioclase compositions in selected basalts. Results are shown in Table 3. Plagioclase phenocrysts in Site 338 basalts have calcic cores (An_{78-80} zoned to An_{60-62}). Groundmass microlites range from An_{70} to An_{64} and probably range down to at least An_{60}. Variations in phenocryst composition in Site 342 basalts suggests a complex history of plagioclase crystallization. There are two compositional groups of phenocrysts, one with An_{70} core composition and a second with An_{60} core composition. Zoning is quite pronounced with rims of An_{44} composition. At Site 344, plagioclase phenocrysts have An_{77} composition and may be continuously zoned to An_{33}. This represents the most extreme compositional variability in any of the basalts analyzed.

All of the plagioclases contain minor amounts of Ti, Mg, and Fe. Generally there is a positive correlation between An content and Ti and Mg abundances. In addition, the Mg/Fe ratio decreases with decreasing An content. The highest Mg/Fe ratios are associated with quenched plagioclase in Site 338 basalts. Probably the partitioning of Mg and Fe into the plagioclase is not an equilibrium process for these plagioclases.

We have also briefly examined the Fe-Ti oxides in these basalts. Surprisingly, most contain primary ilmenite with minor or no titanomagnetite. Analysis of co-existing ilmenite and titanomagnetite could only be accomplished in the coarse diabase at Site 342, indicating crystallization parameters of 1020°-1040°C and $Fo_2 = 10^{-10.5}$-10^{-11} atm.

SUMMARY

All basaltic rocks are either quartz or olivine tholeiites which are best divided on Al_2O_3 and TiO_2 contents. In terms of major elements and limited trace element abundances, samples from Sites 336, 337 and 348 are abyssal tholeiites typical of basalts dredged from active mid-oceanic ridges. Samples from Sites 338, 344, and 345 are high-alumina tholeiites, but some have high Mg/Fe ratios that serve to distinguish them from high-alumina abyssal tholeiites. Basalts with distinctly higher K_2O, TiO_2, and overall greater enrichment in lithophile trace elements, occur at Sites 342, 343, and possibly 350. Diabase at Site 344 appears to contain patches of high TiO_2 FeO material which may represent local segregations of in situ fractionated liquid.

Phase chemical studies indicate the ubiquity of plagioclase and pyroxene, general lack of olivine, and rarity of titanomagnetite relative to ilmenite. Compositional zoning is most pronounced in plagioclase phenocrysts which may have grown largely prior to eruption. Compositional zoning is not extensive in the pyroxenes which are all diopsidic augites, and trends are indicative of rather fast, metastable crystallization. Minor element abundances in both plagioclase (Fe, Mg, Ti) and pyroxene (Al, Ti, Cr) indicate an influence of bulk mineral chemistry, but also cooling rate has had a large effect.

TABLE 3B – *Continued*

19	20	21	22	23	24	25	26	27	28
51.00	56.65	53.72	55.74	53.66	53.14	54.94	55.56	54.50	51.82
0.03	0.11	0.09	0.10	0.08	0.10	0.10	0.09	0.10	0.03
30.81	27.70	29.08	25.86	29.25	29.97	28.40	27.89	27.94	29.90
0.55	0.90	0.76	1.33	0.73	0.71	1.05	1.32	1.02	0.69
–	0.01	–	–	0.01	0.02	0.01	0.01	–	0.01
0.18	0.10	0.21	0.17	0.15	0.15	0.04	0.01	0.03	0.16
15.30	9.04	13.18	8.83	13.09	13.47	12.10	10.16	11.23	13.59
2.75	6.02	3.96	5.99	3.87	3.64	4.34	5.11	4.79	3.68
0.32	0.48	0.31	0.58	0.30	0.28	0.57	0.76	0.48	0.24
100.94	101.01	101.31	98.6	101.14	101.48	101.55	100.91	100.09	100.12
2.311	2.529	2.412	2.553	2.411	2.382	2.459	2.496	2.470	2.359
0.001	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002
1.645	1.457	1.539	1.396	1.549	1.584	1.498	1.477	1.493	1.604
0.021	0.033	0.028	0.051	0.027	0.026	0.039	0.049	0.038	0.26
–	–	–	–	–	–	–	–	–	–
0.012	0.006	0.014	0.011	0.010	0.010	0.002	0.001	0.002	0.011
0.742	0.432	0.634	0.433	0.630	0.647	0.580	0.489	0.545	0.663
0.242	0.521	0.345	0.532	0.337	0.317	0.376	0.445	0.421	0.325
0.018	0.027	0.018	0.018	0.017	0.016	0.032	0.043	0.028	0.014
3.956	3.986	3.951	4.092	3.960	3.966	3.957	3.973	3.963	3.963
74	45	64	44	64	66	60	51	55	66
0.57	0.18	0.50	0.21	0.37	0.38	0.05	0.02	0.05	0.42

29	30	31	32	33	34	35	36	37	38
49.92	49.32	49.26	53.22	56.70	53.44	54.15	53.70	51.60	53.94
0.02	0.02	0.03	0.07	0.12	0.07	0.07	0.09	0.09	0.09
31.87	31.87	31.95	29.60	27.17	29.49	28.92	29.40	29.60	29.66
0.68	0.54	0.67	1.06	1.11	0.98	0.81	1.19	0.86	0.90
–	0.04	–	0.01	–	–	–	0.01	–	–
0.09	0.14	0.13	0.05	0.12	0.09	0.16	0.06	0.07	0.08
15.60	15.90	15.70	12.94	10.13	12.63	12.67	11.91	13.11	12.11
2.34	2.29	2.16	3.96	5.39	4.32	4.17	4.49	3.90	4.62
0.21	0.15	0.16	0.28	0.49	0.27	0.22	0.34	0.21	0.19
100.73	100.27	100.06	101.19	101.23	101.29	101.17	101.19	99.44	101.59
2.268	2.253	2.253	2.395	2.531	2.401	2.401	2.430	2.414	2.411
–	–	0.001	0.002	0.004	0.002	0.002	0.003	0.003	0.003
1.706	1.716	1.722	1.570	1 430	1.562	1.529	1.557	1.599	1.563
0.025	0.020	0.025	0.039	0.041	0.036	0.030	0.045	0.033	0.034
–	0.001	–	–	–	–	–	–	–	–
0.006	0.010	0.009	0.003	0.008	0.006	0.011	0.004	0.001	0.005
0.759	0.778	0.769	0.623	0.485	0.608	0.609	0.573	0.644	0.580
0.206	0.203	0.191	0.345	0.467	0.376	0.363	0.391	0.347	0.401
0.012	0.009	0.009	0.016	0.028	0.015	0.012	0.019	0.012	0.010
3.974	3.969	3.975	3.965	3.961	3.963	3.959	3.971	3.964	3.974
76	78	77	62	50	61	61	59	64	58
0.24	0.50	0.36	0.08	0.19	0.16	0.37	0.09	0.12	0.15

TABLE 4A
Pyroxenes in Basalts at Sites 348 and 350

	348				350						
	1	2	3	4	5	6	7	8	9	10	11
SiO_2	48.20	49.82	50.84	49.02	50.18	52.01	51.18	51.16	51.09	52.49	53.27
TiO_2	1.05	1.01	1.31	1.25	1.50	0.63	1.27	1.55	1.20	0.61	1.46
Al_2O_3	4.34	3.86	4.01	4.27	4.85	2.16	2.30	4.34	3.25	2.03	1.99
Cr_2O_3	0.08	0.13	0.15	0.14	0.37	0.20	0.09	0.24	0.25	0.21	0.21
FeO	12.45	13.34	12.21	10.92	8.50	8.74	8.82	9.42	8.12	9.22	8.60
MnO	0.49	0.45	0.46	0.43	0.25	0.32	0.31	0.27	0.24	0.27	0.26
MgO	14.87	15.85	16.44	14.84	16.01	15.30	18.29	15.32	14.99	14.91	16.41
CaO	18.00	16.52	16.08	20.20	19.12	19.06	16.30	17.86	19.70	20.61	18.84
Na_2O	0.16	0.24	0.22	0.27	0.28	0.17	0.20	0.30	0.24	0.17	0.28
Total	99.64	101.22	101.72	101.34	101.12	98.59	98.76	100.46	99.08	100.52	101.32
Si	1.827	1.867	1.865	1.838	1.839	1.949	1.906	1.882	1.907	1.941	1.938
Ti	0.029	0.028	0.036	0.034	0.043	0.017	0.035	0.043	0.033	0.017	0.040
Al	0.194	0.167	0.173	0.185	0.209	0.095	0.101	0.188	0.143	0.088	0.085
Cr	0.002	0.003	0.004	0.004	0.010	0.006	0.002	0.007	0.007	0.006	0.006
Fe	0.394	0.410	0.374	0.335	0.260	0.274	0.275	0.289	0.253	0.285	0.261
Mn	0.015	0.014	0.014	0.013	0.007	0.010	0.009	0.008	0.007	0.008	0.008
Mg	0.840	0.868	0.899	0.813	0.874	0.855	1.015	0.840	0.834	0.822	0.890
Ca	0.731	0.650	0.632	0.795	0.751	0.765	0.650	0.704	0.787	0.816	0.734
Na	0.012	0.017	0.015	0.019	0.020	0.012	0.015	0.021	0.017	0.012	0.020
Al^{IV}	0.173	0.133	0.135	0.162	0.161	0.051	0.094	0.118	0.093	0.059	0.062
Al^{VI}	0.021	0.034	0.038	0.023	0.048	0.044	0.007	0.070	0.050	0.029	0.023
ΣTet	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
ΣCations	4.044	4.024	4.012	4.036	4.013	3.983	4.008	3.982	3.988	3.983	3.982
Wo	37	34	33	41	40	40	33	48	42	42	39
En	42	45	47	41	46	45	52	46	44	42	47
Fs	21	21	20	18	14	15	15	16	14	16	14
Quad	88.6	89.3	88.7	88.3	86.7	93.1	92.2	87.2	90.0	94.1	92.2
Others	11.4	10.7	11.3	11.7	13.3	6.9	7.8	12.8	10.0	5.9	7.8

Note: 1, 2 = Phenocrysts; 3, 4 = groundmass grains; 5-7 = center to edge of phenocrysts; 8 = center of phenocryst; 9-11 = center to edge of phenocrysts.

TABLE 4B
Pyroxenes in Basalts at Site 336 and 337

	1	2	3	4	5	6	7	8
SiO_2	51.26	52.13	52.13	52.01	50.05	51.26	52.13	52.13
TiO_2	0.52	0.42	0.47	0.72	0.84	0.52	0.42	0.47
Al_2O_3	3.56	3.92	2.69	2.20	4.31	3.56	3.92	2.69
Cr_2O_3	0.09	0.15	0.17	0.01	0.13	0.09	0.15	0.17
FeO	9.14	5.94	6.16	5.96	8.32	9.14	5.96	6.16
MnO	0.18	0.19	0.19	0.21	0.21	0.18	0.19	0.19
MgO	17.08	16.71	16.79	16.78	16.02	17.08	16.71	16.79
CaO	18.07	20.88	21.20	20.71	18.08	18.07	20.88	21.20
Na_2O	0.17	0.17	0.17	0.22	0.23	0.17	0.17	0.17
Total	100.07	100.51	99.97	98.82	98.19	100.07	100.53	99.97
Si	1.892	1.900	1.916	1.930	1.879	1.892	1.900	1.916
Ti	0.014	0.011	0.013	0.020	0.023	0.014	0.011	0.013
Al	0.154	0.168	0.116	0.096	0.190	0.154	0.168	0.116
Cr	0.002	0.004	0.005	0.001	0.004	0.002	0.004	0.005
Fe	0.282	0.181	0.189	0.185	0.261			
Mn	0.005	0.005	0.005	0.006	0.006			
Mg	0.940	0.908	0.920	0.928	0.896			
Ca	0.714	0.815	0.835	0.823	0.727			
Na	0.012	0.012	0.012	0.016	0.017			
Al^{IV}	0.108	0.100	0.084	0.070	0.121	0.108	0.100	0.084
Al^{VI}	0.046	0.068	0.032	0.026	0.069	0.046	0.068	0.032
ΣTet	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
ΣCations	4.015	4.004	4.011	4.005	4.003			
Wo	37	43	42	43	38			
En	48	47	47	48	47			
Fs	15	10	11	9	15			
Quad	91.1	90.4	92.7	93.3	88.7			
Others	8.9	9.6	7.3	6.7	11.3			

Note: 6-8 Edge to center of phenocryst.

TABLE 4C
Pyroxenes in Basalts at Site 338

	1	2	3	4	5	6	7	8	9	10	11
SiO_2	49.20	50.90	51.81	50.56	50.32	52.02	52.35	49.80	50.95	49.74	50.96
TiO_2	0.54	0.62	0.69	0.40	0.69	0.55	0.56	0.35	0.40	0.55	0.53
Al_2O_3	4.93	4.06	4.01	3.25	2.99	2.20	2.33	5.00	2.57	3.26	2.99
Cr_2O_3	0.43	0.34	0.51	0.37	0.44	0.08	0.08	1.06	0.64	0.28	0.33
FeO	6.57	5.79	5.48	6.80	5.36	7.92	9.89	5.98	5.82	7.08	7.80
MnO	0.17	0.15	0.14	0.19	0.18	0.22	0.23	0.43	0.34	0.39	0.43
MgO	17.32	17.32	17.93	19.43	17.73	17.18	16.58	16.99	17.71	17.86	17.57
CaO	20.27	20.93	21.25	19.24	21.72	20.14	19.09	20.49	20.33	20.14	19.83
Na_2O	0.22	0.23	0.23	0.17	0.26	0.20	0.18	0.16	0.17	0.18	0.18
Total	99.71	100.34	102.05	100.41	99.69	100.51	101.30	100.26	98.93	99.48	99.62
Si	1.824	1.864	1.863	1.872	1.869	1.913	1.919	1.861	1.912	1.883	1.916
Ti	0.015	0.017	0.018	0.010	0.018	0.015	0.015	0.009	0.011	0.015	0.015
Al	0.215	0.175	0.169	0.137	0.127	0.095	0.100	0.220	0.113	0.145	0.132
Cr	0.012	0.010	0.014	0.010	0.012	0.002	0.002	0.031	0.019	0.008	0.009
Fe	0.203	0.177	0.165	0.203	0.162	0.243	0.303	0.187	0.182	0.222	0.214
Mn	0.005	0.004	0.004	0.005	0.005	0.007	0.007	0.013	0.011	0.012	0.013
Mg	0.956	0.946	0.961	1.037	0.954	0.942	0.906	0.891	0.935	0.951	0.928
Ca	0.804	0.821	0.819	0.738	0.840	0.793	0.750	0.780	0.817	0.776	0.759
Na	0.015	0.016	0.016	0.011	0.018	0.014	0.013	0.011	0.012	0.013	0.013
Al^{IV}	0.176	0.136	0.137	0.128	0.127	0.087	0.081	0.139	0.088	0.117	0.084
Al^{VI}	0.039	0.039	0.032	0.009	–	0.008	0.019	0.081	0.025	0.028	0.048
ΣTet	2.000	2.000	2.000	2.000	1.996	2.000	2.000	2.000	2.000	2.000	2.000
ΣCations	4.049	4.030	4.029	4.025	4.005	4.024	4.015	4 003	4.012	4.025	3.999
Wo	41	42	42	37	43	40	38	42	42	40	40
En	49	49	49	52	49	48	42	48	48	49	49
Fs	10	9	9	11	8	12	20	10	10	11	11
Quad	88.2	89.7	89.7	91.8	91.5	93.6	93.4	86.7	92.0	90.9	91.3
Others	11.8	10.3	10.3	8.2	9.5	6.4	6.6	13.3	8.0	9.1	8.7

Note: 1, 2 = Edge and center of phenocryst; 3 = center of small phenocryst; 4, 5 = edge and center of phenocryst; 6, 7 = groundmass grains; 8–11 = phenocrysts.

TABLE 4D
Pyroxenes in Basalts at Site 342

	1	2	3	4	5	6	7	8	9	10	11	12
SiO_2	52.17	51.53	51.61	49.64	51.51	49.50	52.54	51.31	52.04	49.38	50.82	51.35
TiO_2	0.88	0.88	1.07	1.13	0.87	1.07	0.68	1.06	0.89	1.09	1.03	0.88
Al_2O_3	1.89	2.97	2.55	3.50	1.63	1.31	2.11	2.73	1.82	2.07	3.39	2.98
Cr_2O_3	0.07	0.20	0.34	0.51	0.03	0.01	0.28	0.33	0.07	0.02	0.31	0.29
FeO	8.72	8.55	9.40	8.91	10.65	11.65	9.29	8.22	11.63	17.73	8.22	9.42
MnO	0.24	0.21	0.24	0.17	0.26	0.31	0.22	0.18	0.26	0.36	0.20	0.25
MgO	17.19	16.53	17.33	17.00	17.14	16.69	18.20	16.15	16.33	12.64	17.57	17.25
CaO	16.43	16.81	16.52	17.08	16.29	16.69	16.58	18.55	15.98	15.19	18.47	17.00
Na_2O	0.22	0.31	0.22	0.27	0.22	0.23	0.24	0.23	0.25	0.23	0.28	0.26
Total	97.81	97.99	99.28	98.21	98.60	97.46	100.14	98.76	99.25	98.71	99.19	99.68
Si	1.955	1.930	1.916	1.869	1.935	1.904	1.930	1.916	1.946	1.916	1.888	1.902
Ti	0.024	0.024	0.030	0.032	0.024	0.031	0.018	0.029	0.025	0.032	0.028	0.024
Al	0.083	0.131	0.000	0.155	0.072	0.059	0.091	0.120	0.080	0.094	0.148	0.130
Cr	0.002	0.006	0.010	0.015	0.001	0.001	0.008	0.009	0.002	0.001	0.009	0.008
Fe	0.273	0.267	0.292	0.280	0.334	0.374	0.285	0.256	0.364	0.575	0.255	0.291
Mn	0.007	0.006	0.007	0.005	0.008	0.010	0.007	0.005	0.008	0.012	0.006	0.007
Mg	0.960	0.922	0.959	0.954	0.960	0.957	0.996	0.899	0.910	0.731	0.918	0.953
Ca	0.659	0.674	0.657	0.689	0.656	0.687	0.652	0.742	0.640	0.631	0.736	0.674
Na	0.016	0.022	0.016	0.020	0.016	0.017	0.017	0.017	0.018	0.017	0.020	0.018
Al^{IV}	0.045	0.070	0.084	0.131	0.065	0.059	0.070	0.084	0.054	0.084	0.112	0.098
Al^{VI}	0.038	0.061	0.027	0.024	0.007	–	0.021	0.037	0.026	0.010	0.036	0.032
ΣTet	2.000	2.000	2.000	2.000	2.000	1.963	2.000	2.000	2.000	2.000	2.000	2.000
ΣCations	3.979	3.982	9.998	4.019	4.006	4.040	4.004	3.994	3.993	4.009	4.008	4.007
Wo	35	36	34	36	34	34	34	39	33	32	38	35
En	51	49	50	50	49	47	51	47	47	38	48	50
Fs	14	15	16	14	17	19	15	14	20	30	14	15
Quad	93.4	90.7	91.6	89.4	94.1	94.5	93.2	91.2	93.5	92.5	90.0	91.1
Others	6.6	9.3	8.4	10.6	5.9	5.5	6.8	8.8	6.5	7.5	10.0	8.9

	13	14	15	16	17	18	19	20	21	22	23
SiO_2	50.93	50.28	51.90	51.37	51.83	51.34	52.18	53.19	51.61	53.61	52.56
TiO_2	1.01	1.05	1.49	1.22	0.91	1.15	0.68	0.77	0.67	0.95	1.02
Al_2O_3	3.16	3.37	3.14	2.23	1.90	2.40	1.87	2.05	1.99	3.01	3.07
Cr_2O_3	0.42	0.28	0.13	0.09	0.14	0.22	0.26	0.26	0.06	0.33	0.49
FeO	8.30	7.71	12.73	11.81	10.59	8.26	9.04	9.14	8.70	8.16	8.90
MnO	0.21	0.20	0.24	0.27	0.24	0.23	0.22	0.19	0.22	0.18	0.17
MgO	16.50	16.46	16.14	15.85	18.62	14.86	17.33	17.92	17.59	16.25	15.73
CaO	19.08	19.95	16.19	16.66	16.09	18.99	17.75	16.95	17.31	18.98	17.82
Na_2O	0.26	0.27	0.25	0.24	0.20	0.28	0.28	0.27	0.22	0.26	0.26
Total	99.87	99.57	102.21	99.74	100.52	97.73	99.61	100.74	98.37	101.13	100.02
Si	1.887	1.870	1.895	1.920	1.909	1.939	1.933	1.940	1.931	1.927	1.933
Ti	0.028	0.029	0.041	0.034	0.025	0.032	0.019	0.021	0.019	0.026	0.028
Al	0.138	0.148	0.135	0.098	0.082	0.106	0.081	0.088	0.088	0.129	0.133
Cr	0.012	0.008	0.003	0.002	0.004	0.006	0.007	0.007	0.001	0.009	0.014
Fe	0.257	0.240	0.389	0.369	0.326	0.261	0.280	0.279	0.272	0.248	0.273
Mn	0.006	0.006	0.007	0.008	0.007	0.007	0.007	0.006	0.007	0.005	0.005
Mg	0.911	0.913	0.878	0.883	1.022	0.837	0.957	0.974	0.981	0.880	0.862
Ca	0.757	0.795	0.633	0.667	0.635	0.768	0.704	0.662	0.694	0.739	0.702
Na	0.018	0.019	0.017	0.017	0.014	0.020	0.020	0.019	0.016	0.019	0.019
Al^{IV}	0.113	0.130	0.105	0.080	0.082	0.061	0.060	0.069	0.073	0.067	0.108
Al^{VI}	0.025	0.018	0.030	0.018	–	0.045	0.014	0.028	0.019	0.056	0.066
ΣTet	2.000	2.000	2.000	2.000	1.991	2.000	2.000	2.000	2.000	2.000	2.000
ΣCations	4.014	4.028	3.998	3.998	4.024	4.006	4.008	3.996	4.009	3.982	3.969
Wo	39	40	33	35	32	41	36	34	36	39	38
En	47	46	46	46	51	45	49	50	50	53	47
Fs	14	14	21	19	17	14	15	16	14	18	15
Quad	90.5	90.2	90.3	92.3	93.7	90.2	93.5	93.1	93.6	90.8	90.2
Others	9.5	9.8	9.7	7.7	6.3	9.8	6.5	6.9	6.4	9.2	9.8

Note: 1-3 = Edge to center, phenocryst; 4, 5 = edge to center, phenocryst; 6-8 = edge to center, phenocryst; 9, 10 = groundmass microlites; 11, 12 = edge and center of phenocryst; 13, 14 = center and edge of phenocryst; 15 = inclusion in plagioclase; 16-23 = microphenocrysts.

TABLE 4E
Pyroxenes in Basalts at Site 344

	1	2	3	4	5	6	7	8	9	10	11	12	13
SiO_2	52.25	51.95	50.78	51.01	51.74	50.83	50.89	50.26	50.40	50.20	50.15	50.35	50.64
TiO_2	1.11	1.08	1.11	1.08	1.08	0.74	0.62	0.67	1.32	0.97	0.91	1.09	0.99
Al_2O_3	4.00	4.21	4.90	4.61	4.04	2.93	2.85	2.33	2.90	2.83	2.01	1.98	1.91
Cr_2O_3	0.33	0.40	0.55	0.51	0.41	0.48	0.52	0.20	0.05	0.06	0.06	0.06	0.06
FeO	4.76	4.94	5.104	5.54	5.34	4.44	4.57	5.35	9.31	7.99	13.28	11.73	12.29
MnO	0.16	0.16	0.14	0.18	0.17	0.42	0.40	0.49	0.45	0.55	0.74	0.56	0.61
MgO	15.95	16.56	16.28	15.79	15.96	17.32	17.18	17.24	15.66	16.75	13.48	14.12	14.11
CaO	20.94	22.11	21.67	21.11	21.49	23.25	23.12	22.85	18.39	20.10	18.52	20.74	20.80
Na_2O	0.25	0.31	0.22	0.23	0.22	0.22	0.23	0.21	0.30	0.28	0.30	0.36	0.36
Total	99.75	101.73	100.69	100.06	100.45	100.63	100.38	99.60	98.78	99.73	99.45	100.99	101.77
Si	1.908	1.873	1.850	1.887	1.901	1.878	1.846	1.870	1.895	1.872	1.912	1.889	1.890
Ti	0.030	0.029	0.030	0.029	0.029	0.020	0.016	0.018	0.037	0.027	0.026	0.030	0.027
Al	0.172	0.179	0.210	0.194	0.171	0.125	0.122	0.102	0.128	0.124	0.090	0.087	0.084
Cr	0.009	0.011	0.015	0.014	0.011	0.013	0.015	0.006	0.001	0.001	0.001	0.001	0.001
Fe	0.145	0.149	0.153	0.165	0.161	0.134	0.138	0.166	0.292	0.249	0.423	0.368	0.383
Mn	0.005	0.004	0.004	0.005	0.005	0.012	0.012	0.015	0.014	0.016	0.023	0.018	0.019
Mg	0.868	0.889	0.884	0.842	0.858	0.935	0.929	0.956	0.878	0.931	0.766	0.790	0.785
Ca	0.819	0.854	0.846	0.809	0.830	0.902	0.976	0.911	0.741	0.803	0.757	0.834	0.832
Na	0.018	0.021	0.016	0.016	0.015	0.015	0.016	0.015	0.022	0.020	0.022	0.026	0.026
Al^{IV}	0.092	0.127	0.150	0.103	0.099	0.122	0.122	0.102	0.105	0.124	0.088	0.087	0.084
Al^{VI}	0.080	0.052	0.060	0.091	0.072	0.003	–	–	0.023	–	0.002	–	–
ΣTet	2.000	2.000	2.000	2.000	2.000	2.000	1.968	1.972	2.000	1.996	2.000	1.976	1.974
ΣCations	3.974	4.009	4.008	3.971	3.981	4.034	4.070	4.059	4.008	4.043	4.020	4.043	4.047
Wo	44	47	45	45	45	46	48	45	39	40	39	42	41
En	47	48	47	46	46	47	45	47	46	47	39	40	39
Fs	9	5	8	9	9	7	7	8	15	13	22	18	20
Quad	88.6	88.5	87.2	87.5	88.8	91.4	91.8	92.8	90.4	91.3	92.3	92.4	96.7
Others	11.4	11.5	12.8	12.5	11.2	8.6	8.2	7.2	9.6	8.7	7.7	7.6	3.3

	14	15	16	17	18	19	20	21	22	23	24	25	26
SiO_2	51.19	52.25	51.95	50.78	51.01	52.74	50.55	50.40	49.26	50.20	50.15	50.35	50.64
TiO_2	0.98	1.11	1.08	1.11	1.08	1.08	1.05	1.32	1.23	0.97	0.91	1.09	0.99
Al_2O_3	1.85	4.00	4.21	4.90	4.61	4.04	2.39	2.90	3.30	2.83	2.01	1.98	1.91
Cr_2O_3	0.07	0.33	0.40	0.55	0.51	0.41	0.04	0.05	0.06	0.06	0.06	0.06	0.06
FeO	12.89	4.76	4.95	5.04	5.54	5.34	11.62	9.31	8.02	7.99	13.28	11.73	12.29
MnO	0.66	0.16	0.15	0.14	0.18	0.17	0.62	0.45	0.39	0.53	0.74	0.56	0.61
MgO	13.61	15.96	16.56	16.28	15.79	15.96	13.82	15.66	16.65	16.75	13.48	14.12	14.11
CaO	20.53	20.94	22.11	21.67	21.11	21.49	19.41	18.39	20.59	20.10	18.52	20.74	20.80
Na_2O	0.34	0.25	0.31	0.22	0.23	0.22	0.34	0.30	0.26	0.28	0.30	0.36	0.36
Total	102.12	99.76	101.72	100.69	100.06	101.45	99.84	98.78	99.76	99.71	99.45	100.99	101.77
Si	1.905	1.908	1.878	1.840	1.897	1.901	1.879	1.895	1.812	1.872	1.912	1.889	1.890
Ti	0.027	0.030	0.029	0.030	0.029	0.029	0.030	1.037	0.035	0.027	0.026	0.030	0.027
Al	0.081	0.172	0.179	0.210	0.194	0.171	0.109	0.128	0.149	0.124	0.090	0.087	0.084
Cr	0.002	0.009	0.011	0.015	0.014	0.011	0.001	0.001	0.002	0.001	0.001	0.001	0.001
Fe	0.401	0.145	0.149	0.153	0.165	0.161	0.376	0.292	0.257	0.249	0.423	0.368	0.383
Mn	0.020	0.005	0.004	0.004	0.005	0.005	0.020	0.014	0.012	0.016	0.023	0.018	0.019
Mg	0.755	0.868	0.889	0.884	0.842	0.858	0.797	0.878	0.951	0.931	0.766	0.790	0.785
Ca	0.818	0.819	0.854	0.846	0.809	0.830	0.805	0.741	0.845	0.803	0.757	0.834	0.832
Na	0.024	0.018	0.021	0.016	0.016	0.015	0.025	0.022	0.019	0.020	0.022	0.026	0.026
Al^{IV}	0.081	0.092	0.122	0.150	0.103	0.099	0.109	0.105	0.149	0.124	0.088	0.087	0.084
Al^{VI}	–	0.080	0.057	0.060	0.091	0.072	–	0.023	–	–	0.002	–	–
ΣTet	1.986	2.000	2.000	2.000	2.000	2.000	1.988	2.000	1.961	1.996	2.000	1.976	1.974
ΣCations	4.033	3.974	4.014	4.008	3.971	3.981	4.042	4.008	4.082	4.043	4.020	4.043	4.047
Wo	41	45	45	45	44	45	41	39	41	40	39	42	41
En	38	47	47	47	46	46	40	46	46	47	39	39	39
Fs	21	8	8	8	10	9	19	15	13	13	22	19	20
Quad	92.7	88.6	88.5	87.2	87.5	88.8	91.4	90.4	90.4	91.3	92.3	92.4	92.7
Others	7.3	11.4	11.5	12.8	12.5	11.2	8.6	9.6	9.6	8.7	7.7	7.6	7.3

Note: 1-3 = Edge-center of phenocryst; 4, 5 = center of phenocryst; 6-8 = center-edge of phenocryst; 9, 10 = center of phenocrysts; 11-14 = individual phenocrysts; 15-19 = center of phenocrysts; 20-22 = center to edge of phenocryst; 22-26 = center to edge of phenocryst.

TABLE 5
Spinels in Leg 38 Basalts

	Site						
	342	342	342	342	342	344	344
TiO_2	23.32	49.50	24.01	21.87	49.51	47.54	47.56
Al_2O_3	1.47	0.14	0.99	1.69	0.16	0.11	0.22
Cr_2O_3	0.06	0.03	0.08	0.07	–	0.05	0.07
FeO	72.88	49.75	71.00	72.84	48.64	51.01	49.16
MnO	0.35	0.36	0.28	0.47	0.39	0.46	0.61
MgO	0.85	1.28	0.43	0.75	1.76	0.49	2.27
Total	98.93	101.05	96.79	97.69	100.46		
FeO	51.69		52.3	50.4			
Fe_2O_3	23.36		20.8	24.6			
Total	101.10		98.89	99.85			
% Ulv.	54.3		69.7	63.9			
% R_2O_3		8.2			8.5		
Ilmenite Basis							
FeO	38.16	41.83	38.2	37.5	40.96	41.04	38.01
Fe_2O_3	38.72	8.32	36.8	39.7	8.48	10.56	11.36
Total	102.93	101.45	100.79	102.05	101.26	100.25	100.12
-log fO_2		10.5		-11.0			
T°C		1040		1020			

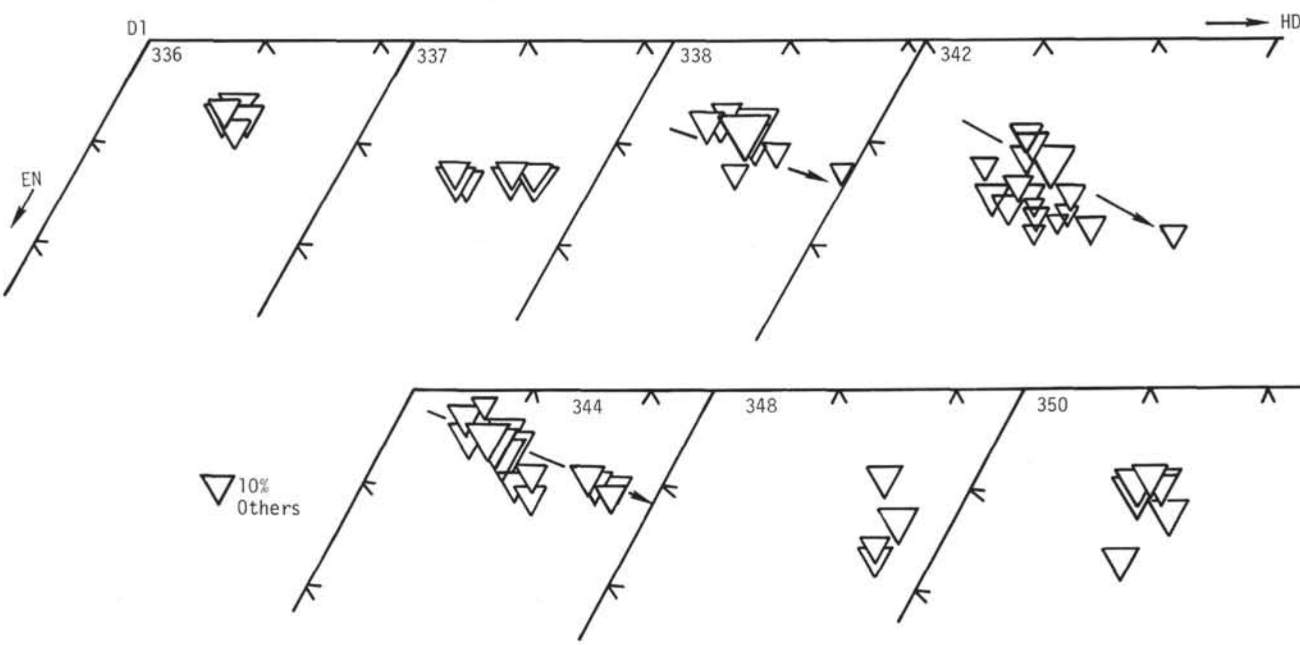

Figure 1. *Pyroxene compositions in Leg 38 basalts in terms of quadrilateral components diopside (DI)-enstatite (EN)-ferrosilite (FS)-hedenbergite (HD). The size of the triangles is an indication of the amount of components other than the above present in the pyroxene. These "other" components are due to solid solutions of Al, Cr, and Ti in the pyroxene structure.*