PRELIMINARY REPORT ON THE PETROGRAPHY AND GEOCHEMISTRY OF BASALT FROM THE PRIBILOF ISLANDS AND VICINITY, SOUTHERN BERING SEA

by
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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards and nomenclature.

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Introduction

Alkali basalt from the Pribilof Islands has been described by several workers (Washington and Keyes, 1930; Barth, 1956; Cox and others, 1966; and Kay, 1977). This report complements the previous reports by providing new petrographic and geochemical data for samples from St. Paul and St. George Islands and from two dredge hauls near St. George Island (Fig. 1).

The geologic setting of the Pribilof Islands region is given by Barth (1956), Hopkins and Einarsson (1965), Cox and others (1966), Hopkins and others (1969), Marlow and others (1976), and Hopkins and Silberman (1978). Quaternary basalt (Table 1) (Cox and others, 1966; Hopkins, 1976; Simpson and others, 1979) is extruded onto the structurally high Pribilof Ridge (Marlow and others, 1976) which consists of rocks as old as late Jurassic (Vallier and others, 1979). Barth (1956) recognized the structural implication of alkalic volcanism in back-arc environments. We plan to interpret alkalic volcanism in the Pribilof Islands within the context of recent tectonic and petrologic findings in the southern Bering Sea.

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Methods

Six samples (designated 64AHP G or just G) were collected from St. George Island by Hopkins in 1964, and 15 (designated 75AHP or just P) were collected from St. Paul Island by Hopkins and Silberman in 1975. Dredge haul samples were collected by Vallier and J. V. Gardner on two cruises of the U.S. Geological Survey research vessel SEA SOUNDER in 1976 (11 samples designated S76-4 DR5) and 1977 (4 samples designated S6-77 DR1). Sample sites are shown in Figures 1 through 5.

All samples were studied in thin section and submitted to the U.S. Geological Survey analytical laboratories for bulk-sample chemical analyses. Several samples were selected for electron-microprobe analysis.

The abundance of the ten major oxides plus Rb and Sr were analyzed by X-ray fluorescence methods as described by Fabbi (1972) and Fabbi and Elsheimer (1976). The percentage error for each oxide or element analyzed is given below (Elseheimer, pers. comm.).

SiO_2	0.36	Na_2O	1.68	Rb	3.0
Al_2O_3	0.98	K_2O	1.58	Sr	4.9
Fe_2O_3	0.74	TiO_2	1.74		
MgO	2.39	P_2O_5	4.55		
CaO	1.09	Mn	2.41		

Total iron was determined as Fe_2O_3. The values were subsequently partitioned into FeO and Fe_2O_3 for calculation of normative minerals using the equation $Fe_2O_3 = TiO_2 + 1.5$ (Irvine and Baragar, 1971). This type of partitioning produces a slightly undersaturated norm.

Trace element analyses were done by 6-step visual semi-quantitative emission spectroscopy with a method modified after Myers and others (1961).

The precision of this method for all elements is +50 and -33 percent of concentration.

Concentrations of Th and U were determined by neutron activation-delayed neutron analysis using the technique described by Millard (1976). Ten percent precision is often achieved, but 30 percent precision is common for this method.

An independent analysis of K_2O was done by flame photometry (Shapiro and Brannock, 1962) using a lithium metaborate fusion technique developed by Ingamells (1970). The analytical precision is one percent of concentration.

Thin-section analyses included counts of 500 grid points using the Glagolev-Chayes method as reviewed by Galehouse (1971). The precision of these counts is as follows:

percent concentration	absolute error percent for confidence levels .50	.95
5 or 95	0.65	1.95
10 or 90	0.90	2.70
20 or 80	1.25	3.60
30 or 70	1.45	4.10
40 or 60	1.50	4.35
50	1.55	4.45

Lee-Wong analyzed 27 polished thin sections by electron microprobe to determine the compositions of pyroxene (18 samples), olivine (25 samples), and iron-titanium oxides (10 samples). Carbon-coated, polished thin sections were analyzed on the U.S. Geological Survey ARL EMX-SM electron microprobe in Menlo Park. The microprobe was operated with an accelerating voltage of 15 kv, a beam current of 0.01 μ amp, and a focused beam width of 1 μm. Data collected on X-ray dispersive spectrometers were corrected for background, matrix absorption, characteristic fluorescence, and atomic number using a modified

version of the FRAME IV data reduction program developed at the National Bureau of Standards (Yakowitz and others, 1973). Standards include natural silicate and oxide samples. The theoretical precision of electron-microprobe analyses is plus or minus 1 to 3 percent when the element present exceeds 10 percent (Beaman and Isasi, 1971).

Petrography

Modal analyses in volume percent are given in Table 2.

The dominant texture of basalts from the Pribilof Islands is intergranular although hyalopilitic, intersertal, ophitic, and subophitic textures are common. Plagioclase, clinopyroxene, olivine, and opaque minerals (iron-titanium oxides) occur as phenocrysts 0.1 to 1.5 mm in longest dimension. Granules, 0.01 to 0.1 mm, and vesicles and amygdules, ranging from 0.1 to 5.0 mm in diameter, are common.

The major minerals plagioclase, olivine, and clinopyroxene comprise 26 to 94 percent of the rock, averaging 70 percent; iron-titanium oxides and nepheline are important accessories. Secondary minerals include clay minerals, carbonate, zeolites, and quartz.

Plagioclase phenocrysts are weakly zoned (less than five percent An) and rarely twinned whereas twinning is common in the laths and microlites. Granules of olivine and clinopyroxene occasionally are enclosed by plagioclase crystals. Excluding the nepheline-bearing samples, plagioclase ranges from 15 to 55 volume percent and averages 35 percent. The composition range, derived from extinction angles, is An 50 to An 75.

Anhedral granules of clinopyroxene are present in all but three samples. Modal abundances range from 0 to 40 percent and average 23 percent. Colors in

plane-polorarized light include shades of buff, brown, red, and lavender. Clinopyroxene is fresh and interstitial, commonly overgrowing olivine.

Olivine occurs as euhedral to subhedral phenocrysts and intergranules in amounts range from 2 to 25 volume percent. The smaller amounts are present in glassy and finer-grained rocks. Alteration is limited to occasional rims and veins of yellow-orange clays.

Fresh euhedral ilmenite and magnetite crystals are common. The combined abundance of both opaque phases ranges from zero to 30 percent.

Half of the samples are holocrystalline and the remainder have groundmass glass (sideromelane) and tachylite. In some samples the glassy groundmass contain fine needles of ilmenite arrayed in a mosaic network, small euhedral grains of magnetite, fine needles of plagioclase in a spherulitic arrangement, and cryptocrystalline minerals.

In two samples (DR1-25 and G142A), a nearly isotropic groundmass mineral with low relief was identified as nepheline by X-ray diffraction methods. Although nepheline occurs in normative mineralogies penetrated by Barth (1956), it has not been reported previously in petrographic descriptions of Pribilof Island basalt. G142A is a sample from a shallow-seated intrusive section on St. George.

Ultramafic inclusions were reported by Barth (1956) and also occur in some of the samples described here. Ultramafic inclusions are composed of olivine and orthopyroxene and display no major reaction rims with the host basalt. A large peridotite nodule in sample G131 contains olivine and enstatite as primary phases. The large crystals are cut by a network of fine fractures which suggests that the nodule has undergone cataclastic deforma-

tion. A peridotite nodule in sample G142A is surrounded by a kelyphitic rim consisting of clinopyroxene. Sample G142A also contains rounded patches similar in composition to the nepheline-rich host, but the patches are magnetite-free.

Amygdules contain a broad assortment of secondary minerals (Table 2). In simplest and most typical form vesicles are lined with a yellow clay (smectite?). Sample DR5-83 contains the most elaborate amygdules; they consist of concentrically arrayed fibrous clay, isotropic zeolite(?), botryoidal calcite, and platey or sparry calcite. Sample G142A contains rare quartz amygdules.

Major-Element Chemistry

Weight percentages of major oxides, normative mineralogies, and differentiation indices are presented in Table 3. MgO variation diagrams given in Figure 6 show the range of values in major element percentages.

The average and standard deviation for the 10 major element oxides are as follows:

SiO_2	46.50 ± 2.52	Na_2O	3.58 ± 0.59
Al_2O_3	14.60 ± 1.46	K_2O	1.20 ± 0.51
$FeTO_3$	12.74 ± 1.31	TiO_2	2.30 ± 0.51
MgO	9.01 ± 3.22	P_2O_5	0.49 ± 0.20
CaO	9.27 ± 0.94	MnO	0.16 ± 0.01

Except for a few samples, the data either cluster or show linear trends on the magnesia variation diagrams (Fig. 6). Those samples that plot outside the clusters or far off linear trends are DR1-25, DR5-83, G131, and G142A. Calcium-rich DR5-83 has 14 percent by volume carbonate amygdules. DR1-25 and G142A also are calcium-rich and are strongly nepheline-normative. Sample G131 hosts a large ultramafic inclusion resulting in high MgO content. Mineral norm calculations by the program GNAP (Bowen, 1971) reveal both nepheline- and hypersthene-normative samples in this collection. St. Paul Island basalts are strictly nepheline-normative. The composition of the one nepheline-normative sample from a dredge haul, DR5-83, is biased by calcareous amygdules. Both St. George and DR1 samples have a mix of nepheline- and hypersthene-normative rocks.

The plot of normative orthoclase, albite, and anorthite in Figure 7 defines an anorthite content of 45 to 90 mole percent if the magma had crystallized entirely.

Minor and Trace Element Chemistry

Minor and trace element contents are given in Table 4. Emission spectrographic analyses of some trace elements from DR5 and DR1 are plotted against MgO in Figure 8. Precision of data based on this method does not permit detailed analysis, but a few of the elements such as Co, Cr and Ni exhibit group trends when plotted against MgO.

The more precisely determined Rb, Sr, U, and Th values are plotted against MgO in Figure 9 and all show a wide scatter. Rb/Sr ratios range from 0.0140 to 0.0617 and Th/U from 0.957 to 7.90. In general Rb/Sr ratios are higher for rocks from St. George Island, but Th/U ratios show random distribution.

Microprobe Analyses

Chemical data for olivine, clinopyroxene, and opaque minerals derived from microprobe analyses are given in Tables 5, 6, and 7, respectively.

Olivine phenocrysts are magnesium-rich and range from 54 to 87 mole percent Fo. FeO variation diagrams suggest no extreme departure from the uniform increase of MnO and CaO, and the decrease of NiO, with increasing FeO content (Fig. 10). Normal zoning of crystals from core to rim ranges up to 13 mole percent Fo. Compositions near 50 percent FeO are from analyses of small granules of olivine in samples DR5-116 and G14.

Normalized clinopyroxene compositions plot in the augite and salite fields of Figure 11. Some titanium-rich clinopyroxenes contain up to 3.4 percent TiO_2. Compositional zoning is limited to two percent MgO from core to rim.

Titanomagnetite and ilmenite are the principal opaque phases. The approximate molecular formula for analyzed titanomagnetite is $Fe^{+2}_{14.0}Fe^{+3}_{3.0}Cr_{1.0}Al_{0.5}Ti_{5.5}O_{32}$. The crystals are heterogeneous. Ilmenite composition approximates $FeTiO_3$.

Preliminary Conclusions

1. All samples are alkalic by virtue of their plot on the alkali-silica diagram (Fig. 12) of MacDonald and Katsura (1964).

2. The alkali-silica and MgO plots show that the basalts from the dredge hauls have compositions more similar to basalts from St. George Island than to basalts from St. Paul Island. Samples from St. Paul are less silica-rich and have a highly nepheline-normative mineralogy. The large range of MgO content in rocks from St. Paul reflect a considerable degree of differentiation.

3. The AFM plot of alkalis, total iron, and magnesium (Fig. 13) shows a differentiation trend similar to that of other alkalic oceanic provinces. Samples from St. Paul have the widest scatter.

4. The similarity in major element chemistry of samples from St. George and the dredge hauls is consistent with the geographic proximity of the three sites with respect to St. Paul (Fig. 1). The location of these samples is also an expression of the extent of the lavas on Pribilof Ridge that are related to volcanic activity on St. George Island. (The Pribilof Ridge is a northwest-trending structural arch underlying the Pribilof Islands.)

5. Rock units on St. Paul Island defined by age-dating (Table 1) are partially corroborated by geochemical data. Except for sample P35C, samples collected from the older volcanic unit (Fig. 2, legend) have the highest MgO values, ranging from 8.1 to 14.6 percent. The samples from the Rush Hill unit contain 6 to 11 percent MgO. The Bogoslov flow complex is well defined by a 5 percent MgO value. Two samples of younger rocks, P27A and P27B, have very different values of 12.6 and 6.7 percent MgO, respectively.

Samples from the Myak basalt sequence on St. George (Figure 3) have 9.1

to 9.5 percent MgO. Other St. George samples from the Casacade Point basalt sequence contain 9.9 to 22.0 percent MgO.

6. While mineral norms and modes are not directly comparable because of the degree of magma crystallization, we do find that samples with the highest percentage nepheline in the norm (DR1-25 and G1421A) contain nepheline in the mode. Although DR5-32 has a value of 13 percent nepheline in the norm, the rock is poorly crystallized and nepheline is not apparent in thin section.

7. The alkalic affinities of the Pribilof Island basalts and the regional normal faults are consistent with an extensional tectonic setting on the Bering Sea margin.

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Table 1.--Potassium-argon and geomagnetic age dates of rocks from the Pribilof Islands and Pribilof Ridge.

Age (10^6 years)	site, rock type	normal/reverse geomagnetic event	data source	samples from this study
	St. Paul basalts			
< 0.1	younger flows	N	1, 2	P27A, P27B
0.13 ± 0.02	Rush Hill flow	N	1,2	P26B
0.15 ± 0.02	Bogoslov, north part	N	1,2	P48
≈ 0.1	Bogoslov, south part	N	1,2	P39
--	pillow lava interbedded with Einahnutan marine sediments	N	1,2	P30, P31
0.36 ± 0.08	Einahnuhto Bluffs, oldest exposed flows	N	1,2	P5, P8, P9, P22, P35C, P36B, P41, P100
0.774, 0.836	S76-4 DR5 basalt		3	
	St. George basalts			
1.6 - 1.85	Myak basalt sequence	R	1,4	G14, G186A, G201A
1.85 - 2.0	Tolstoi Point basalt sequence	N (Olduvai event)	1,4	
2.0 - 2.2	Cascade Point basalt sequence	R	1,4	G115B, G131, G142A

1. Cox and others, 1966; 2. Hopkins and others, unp.; 3. Simpson and others, in press; 4. Hopkins and Einarsson, unp. map.

Table 2. Modal analyses of basalt. Mineral proportions have been normalized to 100 percent exclusive of vesicles, which are listed separately. n = number of points counted, tr indicates that the amount present is less than 0.5 percent. Analyses by Lee-Wong.

	DR5-4 n=505	DR5-8 n=515	DR5-32 n=492	DR5-34 n=492	DR5-57 n=510	DR5-83 n=518	DR5-88 n=542	DR5-100 n=454	DR5-111 n=482	DR5-116 n=475	DR5-121 n=468	DR1-19 n=503
Plagioclase												
phenocrysts	--	1	1	--	--	--	9	--	--	--	--	--
laths	33	46	26	39	48	17	13	47	44	49	53	34
microlites	--	--	--	--	--	--	1	--	--	--	--	--
Clinopyroxene												
phenocrysts	1	1	tr	25	--	--	--	--	23	--	24	--
granules	9	23	--	--	22	24	2	28	--	22	--	--
Olivine												
phenocrysts	5	12	18	8	12	8	11	10	12	16	12	9
granules	--	--	--	--	12	--	--	3	3	4	1	--
iddingsitized	5	--	--	--	--	7	--	--	--	--	--	4
Opaque Minerals	--	11	--	14	6	4	--	9	16	8	10	--
Amygdules												
clay	--	--	--	--	--	5	5	--	--	--	--	6
carbonate	--	--	--	--	--	12	--	--	--	--	--	1
zeolite	--	--	--	--	--	1	2	--	--	--	--	--
quartz	--	--	--	--	--	--	--	--	--	--	--	--
Nepheline	--	--	--	--	--	--	--	--	--	--	--	--
Sideromelane	--	--	--	--	--	--	21	--	tr	1	--	--
Tachylite	46		52	--	--	20	35	--	--	--	--	46
Clay	1	7	2	13	tr	2	1	3	2	--	--	--
Xenoliths	--	--	--	--	--	--	--	--	--	--	--	--
Vesicles	1	--	10	3	2	1	--	10	10	8	11	--

Table 2. (continued)

	DR1-24 n=489	DR1-25 n=503	DR1-27 n=511	P5 n=501	P8 n=497	P9 n=518	P22 n=521	P26B n=511	P27A n=472	P27B n=438	P30 n=486	P31 n=482
Plagioclase												
phenocrysts	--	--	10	--	--	--	--	--	--	--	--	--
laths	29	--	20	48	22	44	39	39	--	13	29	28
microlites	--	--	--	--	--	--	--	--	35	--	--	--
Clinopyroxene												
phenocrysts	--	--	2	--	5	--	--	tr	--	--	37	--
granules	27	40	1	26	29	29	31	22	35	34	--	32
Olivine												
phenocrysts	12	6	2	19	22	16	13	8	7	18	24	18
granules	1	--	--	--	--	--	--	--	--	--	--	--
iddingsitized	--	4	--	--	--	--	--	--	--	--	--	--
Opaque Minerals	22	13	--	7	21	10	16	30	23	9	6	15
Amygdules												
clay	--	3	2	--	--	--	--	--	--	--	--	--
carbonate	--	1	tr	--	--	--	--	--	--	--	--	--
zeolite	--	--	--	--	--	--	--	--	--	--	--	tr
quartz	--	--	--	--	--	--	--	--	--	--	--	--
Nepheline	--	31	--	--	--	--	--	--	--	--	--	--
Sideromelane	--	--	--	--	--	--	--	--	--	--	--	--
Tachylite	--	--	58	--	--	--	1	--	--	13	--	7
Clay	8	2	5	--	--	--	--	--	--	--	4	--
Xenoliths	--	--	--	--	--	--	--	--	--	13	--	--
Vesicles	3	--	--	5	6	3	6	2	6	15	6	6

Table 2. (continued)

	P35C n=465	P36B n=490	P39 n=419	P41 n=484	P48 n=407	P100 n=533	G14 n=510	G115B n=467	G131 n=342	G142A n=515	G186A n=534	G201A n=433
Plagioclase												
phenocrysts	--	--	21	1	1	1	1	--	--	--	--	--
laths	21	46	12	28	20	24	46	37	44		39	40
microlites	--	--	--	--	--	--	--	--	--	--	--	--
Clinopyroxene												
phenocrysts	tr	--	1	6	--	1	1	--	--	--	--	--
granules	--	26	21	19	23	21	27	23	28	39	26	26
Olivine												
phenocrysts	5	19	5	12	3	9	16	11	19	12	9	4
granules	--	--	--	--	--	--	1	--	--	--	--	--
iddingsitized	--	--	--	--	--	--	--	--	--	--	--	13
Opaque Minerals	3	8	10	15	13	21	9	10	9	13	25	16
Amygdules												
clay	--	--	--	--	--	--	--	5	--	--	--	--
carbonate	--	--	--	--	--	--	--	--	--	--	--	--
zeolite	--	--	--	--	--	--	--	--	--	--	--	--
quartz	--	--	--	--	--	--	--	--	--	11	--	--
Nepheline	--	--	--	--	--	--	--	--	--	20	--	--
Sideromelane	--	--	--	--	--	--	--	--	--	--	--	--
Tachylite	71	--	30	18	40	22	--	14	--	4	--	1
Clay	--	--	--	--	--	--	--	tr	--	tr	tr	--
Xenoliths	--	--	--	--	--	--	--	--	--	1	--	--
Vesicles	10	5	17	7	19	22	4	8	17	7	2	17

Table 3. Major element oxides and calculated normative minerals in weight percent. See Table 1 for key to rock units of P and G samples.

	DR5-4	DR5-8	DR5-32	DR5-34	DR5-57	DR5-83	DR5-88	DR5-100	DR5-111	DR5-116	DR5-121	DR1-19
SiO_2	48.31	48.52	50.01	48.95	48.97	40.44	48.69	48.94	49.41	49.43	49.86	48.74
Al_2O_3	15.12	15.04	14.11	14.99	14.84	12.22	15.17	15.39	15.14	14.88	15.49	14.80
Fe_2O_3	3.54	3.35	3.20	3.39	3.43	3.81	3.55	3.36	3.33	3.44	3.37	3.49
FeO	7.52	8.03	7.45	8.51	8.58	7.43	7.92	6.65	8.42	8.21	7.72	8.06
MgO	7.00	7.76	8.77	8.50	8.42	8.68	7.59	7.55	8.40	7.98	8.02	8.04
CaO	9.57	8.99	8.78	9.09	8.67	12.29	9.17	9.78	8.82	9.02	9.09	9.19
Na_2O	3.53	3.65	3.21	3.47	3.55	3.01	3.39	3.66	3.54	3.55	3.53	3.33
K_2O	0.73	0.89	0.91	0.80	0.78	1.38	1.03	0.86	0.78	0.84	0.82	0.68
TiO_2	2.04	1.85	1.70	1.89	1.93	2.31	2.05	1.86	1.83	1.94	1.87	1.99
P_2O_5	0.46	0.45	0.37	0.35	0.36	0.59	0.39	0.61	0.40	0.40	0.46	0.47
MnO	0.14	0.14	0.15	0.15	0.16	0.17	0.16	0.13	0.15	0.15	0.14	0.15
Total	97.96	98.67	98.66	100.09	99.69	92.33	99.11	98.79	100.22	99.84	100.37	98.94
*K_2O	0.744	0.902	0.923	0.821	0.804	1.375	1.047	0.882	0.799	0.859	0.850	0.683
or	4.40	5.33	5.45	4.72	4.62	8.83	6.14	5.14	4.60	4.97	4.83	4.06
ab	30.49	31.30	27.53	29.34	30.13	2.50	28.94	31.35	29.89	30.09	29.76	28.48
an	23.74	22.32	21.70	22.94	22.32	17.06	23.34	23.31	23.07	22.22	23.91	23.68
ne						13.59						
di-wo	9.04	8.31	8.35	8.28	7.71	18.70	8.35	9.09	7.51	8.34	7.53	8.06
di-en	5.84	5.27	5.57	5.26	4.88	12.97	5.37	6.20	4.76	5.32	4.90	5.20
di-fs	2.60	2.51	2.17	2.48	2.34	4.20	2.42	2.18	2.27	2.49	2.10	2.32
hy-en	2.75	0.34	9.78	1.84	2.95		2.57	0.84	3.62	3.59	5.11	6.16
hy-fs	1.22	0.16	3.81	0.87	1.41		1.16	0.30	1.72	1.68	2.19	2.74
fo	6.46	9.80	4.76	9.84	9.25	7.32	7.80	8.40	8.75	7.71	6.93	6.22
fa	3.17	5.13	2.04	5.12	4.88	2.61	3.88	3.25	4.60	3.98	3.27	3.05
mt	5.24	4.92	4.70	4.91	4.99	5.98	5.19	4.93	4.82	5.00	4.87	5.11
il	3.96	3.56	3.27	3.59	3.68	4.75	3.93	3.58	3.47	3.69	3.54	3.82
ap	1.11	1.08	0.89	0.83	0.86	1.51	0.93	1.46	0.94	0.95	1.09	1.12
Total	100.02	100.03	100.02	100.02	100.02	100.02	100.02	100.03	100.02	100.03	100.03	100.02
Differentiation Index	34.89	36.63	32.98	34.06	34.75	24.92	35.08	36.49	34.49	35.06	34.59	32.54

X-ray fluorescence analyses of oxides by N. Elsheimer and S. Morgan for DR5, DR1, and by B. King for P, G.
*Flame photometry determination of K_2O by P. Klock for DR5, DR1; x-ray fluorescence analyses of K_2O by M. Villareal for P, G.

Table 3. (continued)

	DR1-24	DR1-25	DR1-27	P5	P8	P9	P22	P26B	P27A	P27B	P30	P31
SiO_2	48.30	42.44	49.05	44.23	44.82	44.41	46.04	44.31	45.28	44.47	45.24	45.21
Al_2O_3	14.75	14.03	16.53	12.73	12.59	13.71	14.92	16.55	16.10	13.61	14.23	14.10
Fe_2O_3	3.59	4.17	3.73	3.77	3.48	4.13	3.86	4.53	4.73	3.70	3.69	3.77
FeO	7.42	7.69	6.68	9.39	8.40	9.57	7.80	7.24	7.54	7.52	7.42	7.71
MgO	8.84	6.43	4.79	13.61	14.64	11.67	8.87	6.22	6.66	12.60	11.16	11.02
CaO	9.40	10.95	9.67	8.24	9.09	9.00	9.31	8.77	9.90	9.43	9.96	9.67
Na_2O	3.55	5.39	3.77	3.04	3.00	3.28	3.58	4.94	4.08	3.29	3.47	3.53
K_2O	1.08	1.75	1.41	1.01	1.13	1.02	1.47	2.45	1.84	1.67	1.30	1.35
TiO_2	2.09	2.67	2.23	2.27	1.98	2.63	2.36	3.03	3.23	2.20	2.19	2.27
P_2O_5	0.58	1.24	0.60	0.36	0.39	0.39	0.38	0.84	0.56	0.53	0.37	0.39
MnO	0.13	0.17	0.13	0.18	0.17	0.18	0.16	0.17	0.17	0.16	0.16	0.17
Total	99.73	96.93	98.59	98.83	99.69	99.99	98.75	99.05	100.09	99.18	99.19	99.19
*K_2O	1.103	1.782	1.436	1.050	1.120	1.060	1.540	2.510	1.860	1.710	1.350	1.390
or	6.40	10.67	8.45	6.04	6.70	6.03	8.80	14.62	10.86	9.95	7.74	8.04
ab	28.09	6.90	32.32	16.45	12.92	16.09	19.44	12.33	16.00	10.35	13.74	14.36
an	21.18	9.20	24.36	18.32	17.60	19.68	20.56	15.90	20.16	17.58	19.57	18.79
ne	1.10	21.75	0.02	5.19	6.79	6.32	6.09	16.18	10.02	9.60	8.59	8.54
di-wo	9.09	16.07	8.49	8.63	10.47	9.36	9.90	9.39	10.54	10.90	11.61	11.28
di-en	6.25	10.58	5.37	6.01	7.54	6.39	6.79	6.55	7.43	7.98	8.37	8.05
di-fs	2.12	4.35	2.58	1.90	1.98	2.23	2.32	2.06	2.20	1.89	2.19	2.23
hy-en												
hyfs												
fo	11.09	4.16	4.72	19.82	20.35	15.89	10.92	6.37	6.40	16.58	13.77	13.75
fa	4.14	1.89	2.50	6.90	5.90	6.12	4.10	2.20	2.09	4.32	3.96	4.20
mt	5.22	6.24	5.48	5.53	5.06	5.99	5.67	6.63	6.85	5.41	5.39	5.51
il	3.98	5.23	4.30	4.36	3.77	5.00	4.54	5.81	6.13	4.21	4.19	4.35
ap	1.38	3.03	1.44	0.86	0.93	0.92	0.91	2.01	1.32	1.27	0.88	0.93
Total	100.04	100.07	100.03	100.01	100.01	100.02	100.04	100.05	100.00	100.04	100.00	100.03
Differ-entiation Index	35.59	39.32	40.79	27.68	26.41	28.44	34.33	43.13	36.88	29.90	30.07	30.94

Table 3. (continued)

	P35C	P36B	P39	P41	P48	P100	G14	G115B	G131	G142A	G186A	G201A
SiO_2	45.42	44.38	45.61	45.14	45.55	46.79	48.10	48.48	43.30	40.64	47.77	47.74
Al_2O_3	17.21	13.77	17.03	14.61	16.25	15.46	13.59	14.35	9.44	13.19	14.47	14.07
Fe_2O_3	5.38	4.07	4.61	4.03	4.74	3.81	3.88	3.12	3.17	4.29	3.42	3.32
FeO	7.24	9.23	7.45	8.25	7.68	8.06	8.74	8.61	8.87	8.83	9.08	8.86
MgO	5.00	11.34	4.85	9.04	5.16	8.06	9.10	9.89	21.98	11.20	9.31	9.55
CaO	7.62	8.89	9.85	9.75	10.10	10.10	8.94	8.80	6.35	10.46	8.67	8.45
Na_2O	5.10	3.28	4.25	3.46	4.08	3.63	3.16	3.12	2.28	4.00	3.28	3.34
K_2O	2.77	1.09	1.90	1.32	1.92	1.11	0.91	0.46	0.74	1.27	0.63	0.81
TiO_2	3.88	2.57	3.11	2.53	3.24	2.31	2.38	1.62	1.67	2.79	1.92	1.82
P_2O_5	0.88	0.40	0.65	0.54	0.66	0.41	0.32	0.23	0.26	0.86	0.27	0.25
MnO	0.18	0.18	0.17	0.17	0.17	0.17	0.17	0.16	0.16	0.18	0.18	0.17
Total	100.68	99.20	99.48	98.84	99.55	99.91	99.29	98.84	98.22	97.71	99.00	98.38
*K_2O	2.770	1.130	1.930	1.360	1.960	1.120	0.960	0.480	0.780	1.320	0.650	0.850
or	16.26	6.49	11.29	7.89	11.40	6.56	5.42	2.75	4.45	7.68	3.76	4.86
ab	18.36	16.79	18.70	17.88	18.06	21.48	26.93	26.71	13.37	2.75	28.04	28.73
an	15.78	19.79	21.89	20.68	20.45	22.63	20.35	24.07	13.58	14.62	23.13	21.35
ne	13.27	6.06	9.45	6.36	9.00	5.02			3.40	17.28		
di-wo	6.70	9.20	9.59	10.31	10.67	10.37	9.27	7.76	7.00	13.67	7.74	8.18
di-en	4.95	6.31	6.28	7.02	7.07	6.85	6.12	5.02	5.23	9.61	4.91	5.25
di-fs	1.10	2.16	2.63	2.48	2.83	2.78	2.49	2.21	1.07	2.89	2.33	2.39
hy-en							3.80	6.34			2.48	0.78
hy-fs							1.55	2.79			1.18	0.35
fo	5.20	15.53	4.10	11.04	4.10	9.28	9.04	9.50	35.39	13.27	11.23	12.72
fa	1.28	5.86	1.89	4.30	1.81	4.16	4.06	4.62	7.99	4.40	5.88	6.39
mt	7.75	5.95	6.72	5.91	6.90	5.53	5.67	4.58	4.68	6.37	5.01	4.89
il	7.32	4.92	5.94	4.86	6.18	4.39	4.55	3.11	3.23	5.42	3.68	3.51
ap	2.07	0.96	1.55	1.29	1.57	0.97	0.76	0.55	0.63	2.08	0.65	0.60
Total	100.04	100.02	100.03	100.0	100.04	100.02	100.01	100.01	100.02	100.04	100.02	100.00
Differentiation Index	47.89	29.34	39.44	32.13	38.46	33.06	32.35	29.46	21.22	27.71	31.80	33.59

Table 4. Minor and trace elements in ppm; Rb/Sr and Th/U ratios. < indicates that the amount of element present is less than the detection limit.

	DR5-4	DR5-8	DR5-32	DR5-34	DR5-57	DR5-83	DR5-88	DR5-100	DR5-111	DR5-116	DR5-121	DR1-19
Ba	150	170	170	150	130	220	150	160	130	120	150	110
Be	1	1	1	2	2	2	2	2	1	1	2	1
Co	29	38	36	40	41	39	35	45	38	38	37	35
Cr	210	240	270	240	240	330	230	260	240	270	250	220
Cu	31	29	41	24	40	41	39	39	30	21	18	41
Ga	19	23	18	19	19	16	19	19	19	19	21	20
La	24	23	21	20	21	31	23	27	15	24	24	<
Nb	14	13	12	18	12	22	22	18	9	19	21	17
Ni	130	140	180	150	160	290	120	180	150	190	160	140
Pb	<	<	<	9	8	<	7	<	8	9	7	<
*Rb	14	15	17	14	10	20	14	14	8	14	10	9
Sc	17	21	16	23	17	18	21	26	16	23	25	17
*Sr	460	365	295	315	355	645	390	360	300	310	355	335
%+Th	(1.7)	(1.9)	(1.9)	(1.6)	1.9	4.38	(1.6)	(2.7)	(1.6)	(1.6)	(1.8)	(1.8)
+U	0.46	0.50	0.87	0.36	0.43	1.12	0.57	2.82	0.58	0.45	1.26	0.67
V	150	170	140	200	150	140	190	210	170	200	210	150
Y	20	20	16	22	17	18	22	26	14	24	24	19
Yb	2	2	2	2	2	1	2	3	2	2	2	1
Zn	110	120	98	120	140	100	120	100	110	120	130	120
Zr	72	77	56	88	67	120	83	100	40	120	94	67
Th/U	3.7	3.8	2.2	4.4	4.4	3.9	2.8	1.0	2.8	3.6	1.4	2.7
Rb/Sr	0.030	0.041	0.058	0.044	0.028	0.031	0.036	0.039	0.027	0.045	0.028	0.027

* Rb, Sr analyzed by X-ray fluorescence by N. Eleheimer and S. Morgan for DR5, DR1; by B. King for P, G.

\+ Th, U analyses by H. T. Millard, C. McFee, C. Bliss for DR5, DR1; by H. T. Millard, R. J. Knight, A. J. Bartel, J. P. Hemming, R. J. White, R. J. Vinnola and A. E. Brandt for P, G.

% coefficient of variation exceeds 30 percent for Th analyses enclosed in parentheses ( ).

All other elements determined by emission spectrography. Analysts: Jim Mountjoy for DR5, DR1; Chris Heropoulos for P, G.

Table 4. (continued)

	DR1-24	DR1-25	DR1-27	P5	P8	P9	P22	P26B	P27A	P27B	P30	P31
Ba	140	390	230	150	100	100	150	300	200	200	150	150
Be	2	3	2	2	1	2	2	2	2	2	2	1
Co	39	31	25	70	70	70	50	50	50	70	50	50
Cr	300	160	34	200	200	150	150	50	70	200	200	200
Cu	40	41	29	50	50	50	30	30	50	50	50	50
Ga	19	26	24	20	20	20	20	30	20	20	20	20
La	24	41	23	50	30	30	30	50	30	50	50	50
Nb	17	35	22	10	10	15	10	15	15	10	<	10
Ni	240	100	35	150	150	100	50	30	30	150	100	100
Pb	7	7	7	7	<	15	10	15	150	20	15	15
*Rb	13	14	14	12	20	18	27	25	17	20	18	26
Sc	20	11	16	15	20	15	20	15	20	20	20	20
*Sr	395	1000	570	510	510	550	540	960	710	710	540	530
%+Th	(1.60)	5.63	3.30	(1.78)	(1.16)	(2.00)	4.98	4.92	4.36	3.52	4.08	2.62
+U	0.57	1.70	0.83	0.58	0.85	0.65	0.63	1.50	0.84	0.74	0.94	0.89
V	190	130	160	100	100	100	100	150	100	100	100	100
Y	20	18	21	15	10	10	15	15	10	15	15	15
Yb	2	1	2	2	2	2	2	2	2	2	2	2
Zn	92	150	110	100	100	150	100	100	100	100	100	100
Zr	76	99	88	100	100	70	100	100	100	100	70	70
Th/U	2.8	3.3	4.0	3.1	1.4	3.1	7.9	3.3	5.2	4.8	4.3	2.9
Rb/Sr	0.033	0.014	0.025	0.024	0.039	0.033	0.050	0.026	0.024	0.028	0.033	0.049

Table 4. (continued)

	P35C	P36B	P39	P41	P48	P100	G14	G115B	G131	G142A	G186A	G201A
Ba	200	150	200	150	200	150	100	70	100	200	100	100
Be	2	1	2	2	2	2	1	1	1	2	1	1
Co	30	70	50	50	50	50	52	50	70	50	50	50
Cr	10	150	30	150	50	150	200	200	1000	100	150	200
Cu	50	50	50	50	50	50	50	50	50	50	50	50
Ga	20	20	30	20	20	20	20	20	15	20	20	20
La	50	30	50	50	50	30	50	30	30	70	50	50
Nb	30	10	10	10	15	10	15	15	<	30	10	15
Ni	7	100	15	70	15	50	70	100	500	70	70	100
Pb	7	70	10	<	<	<	50	<	<	30	7	7
*Rb	27	23	24	27	23	14	25	20	25	32	18	22
Sc	10	15	15	15	15	20	20	30	15	15	20	20
*Sr	980	550	780	620	760	540	405	325	350	720	345	375
%+Th	4.21	2.15	2.94	3.13	3.00	2.45	(1.52)	(1.60)	2.47	7.16	(1.64)	(1.65)
+U	1.55	0.78	1.14	0.7	1.12	1.05	0.63	0.26	0.55	1.81	0.52	0.47
V	100	100	150	100	150	100	150	100	70	100	100	100
Y	15	15	15	15	15	15	20	15	10	20	15	15
Yb	2	2	2	2	2	2	2	3	2	2	2	3
Zn	100	150	100	100	100	100	100	100	100	150	100	150
Zr	200	70	100	100	150	100	100	100	70	200	70	70
Th/U	2.7	2.8	2.6	4.3	2.7	2.3	2.4	6.2	4.5	4.0	3.2	3.5
Rb/Sr	0.028	0.042	0.031	0.044	0.030	0.026	0.062	0.062	0.071	0.044	0.052	0.059

Table 5. Electron microprobe data for olivines.
Analyses by F. Lee-Wong.

	DR5-4			DR5-8				DR5-32				DR5-34
SiO_2	38.21	38.20	38.52	38.91	38.82	38.98	39.27	39.13	39.91	38.99	39.29	38.53
FeO	19.36	25.68	20.20	20.51	19.83	19.83	16.32	17.23	16.48	17.11	17.63	21.85
MnO	0.26	0.33	0.25	0.24	0.23	0.24	0.20	0.20	0.21	0.20	0.21	0.25
NiO	0.11	0.09	0.10	0.10	0.09	0.09	0.15	0.13	0.17	0.14	0.13	0.10
MgO	39.99	35.12	39.56	40.72	41.91	41.10	42.88	41.17	43.19	42.27	41.75	37.76
CaO	0.41	0.76	0.47	0.39	0.40	0.37	0.32	0.34	0.33	0.34	0.42	0.47
Total	98.34	100.18	99.10	100.86	101.27	100.60	99.14	98.21	100.30	99.06	99.43	98.96
Cations/4 oxygen												
Si	0.999	1.009	1.003	0.995	0.987	0.997	1.002	1.012	1.006	1.000	1.006	1.011
Fe^{+2}	0.423	0.567	0.439	0.439	0.421	0.424	0.348	0.372	0.347	0.367	0.377	0.479
Mn	0.006	0.007	0.006	0.005	0.005	0.005	0.004	0.004	0.005	0.004	0.005	0.006
Ni	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.002
Mg	1.559	1.383	1.535	1.553	1.588	1.566	1.631	1.587	1.623	1.616	1.593	1.477
Ca	0.011	0.022	0.013	0.011	0.011	0.010	0.009	0.010	0.009	0.009	0.011	0.013
Atomic ratios												
Mg	78.6	70.9	77.7	78.0	79.0	78.7	82.4	81.0	82.4	81.5	80.9	75.5
Fe^{+2}	21.4	29.1	22.3	22.0	21.0	21.3	17.6	19.0	17.6	18.5	19.1	24.5

Table 5. (continued)

	DR5-34			DR5-57				DR5-83				
					core	edge						
SiO_2	37.58	38.54	38.95	38.47	37.86	36.72	37.27	39.77	39.67	39.15	39.74	39.23
FeO	28.57	25.16	21.62	28.68	26.60	34.83	28.54	13.80	15.36	13.42	14.65	18.23
MnO	0.39	0.31	0.28	0.33	0.32	0.49	0.38	0.17	0.16	0.18	0.17	0.24
NiO	0.11	0.10	0.11	0.10	0.08	0.08	0.08	0.15	0.14	0.15	0.14	0.12
MgO	33.93	36.67	39.29	33.08	35.17	27.92	33.26	45.13	45.09	44.47	45.62	42.95
CaO	0.68	0.53	0.45	0.45	0.42	0.62	0.55	0.34	0.43	0.38	0.38	0.16
Total	101.26	101.31	100.70	101.11	100.46	100.65	100.08	99.36	100.84	97.75	100.71	100.94
Cations/4 oxygen												
Si	0.997	1.003	1.003	1.019	1.002	1.011	1.001	1.001	0.991	1.001	0.991	0.992
Fe^{+2}	0.634	0.548	0.465	0.635	0.588	0.802	0.641	0.290	0.321	0.287	0.305	0.385
Mn	0.009	0.007	0.006	0.007	0.007	0.012	0.009	0.004	0.003	0.004	0.004	0.005
Ni	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.002
Mg	1.342	1.423	1.508	1.306	1.387	1.146	1.331	1.693	1.679	1.694	1.696	1.619
Ca	0.019	0.015	0.012	0.013	0.012	0.018	0.016	0.009	0.011	0.010	0.010	0.004
Atomic ratios												
Mg	67.9	72.2	76.4	67.3	70.2	58.8	67.5	85.4	84.0	85.5	84.7	80.8
Fe^{+2}	32.1	27.8	23.6	32.7	29.8	41.2	32.5	14.6	16.0	14.5	15.3	19.2

Table 5. (continued)

	DR5-88				DR5-100			DR5-111				DR5-116
SiO_2	38.08	38.52	38.65	38.66	38.80	39.57	39.21	38.18	39.03	39.21	38.61	37.43
FeO	22.66	21.94	22.06	21.43	20.97	19.13	19.60	24.11	19.68	18.44	19.53	25.30
MnO	0.30	0.26	0.29	0.28	0.23	0.20	0.24	0.33	0.24	0.23	0.24	0.32
NiO	0.09	0.08	0.08	0.09	0.11	0.12	0.11	0.07	0.09	0.10	0.10	0.09
MgO	38.88	39.65	38.58	39.88	40.46	41.10	41.88	36.25	40.92	41.21	40.90	35.41
CaO	0.45	0.46	0.58	0.46	0.43	0.41	0.34	0.58	0.40	0.36	0.40	0.50
Total	100.45	100.91	100.23	100.81	100.99	100.53	101.37	99.51	100.36	99.54	99.78	99.05
Cations/4 oxygen												
Si	0.990	0.992	1.003	0.995	0.994	1.008	0.993	1.008	0.999	1.006	0.995	1.000
Fe^{+2}	0.493	0.473	0.478	0.461	0.449	0.407	0.415	0.532	0.421	0.395	0.421	0.565
Mn	0.006	0.006	0.006	0.006	0.005	01004	0.005	0.007	0.005	0.005	0.005	0.007
Ni	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Mg	1.506	1.523	1.492	1.529	1.544	1.560	1.582	1.427	1.562	1.576	1.571	1.411
Ca	0.012	0.013	0.016	0.013	0.012	0.011	0.009	0.016	0.011	0.010	0.011	0.014
Atomic ratios												
Mg	75.4	76.3	75.7	76.8	77.5	79.3	79.2	72.8	78.8	79.9	78.9	71.4
Fe^{+2}	24.6	23.7	24.3	23.2	22.5	20.7	20.8	27.2	21.2	20.1	21.1	28.6

Table 5. (continued)

	DR5-116	DR5-121							DR1-19			DR1-24
			edge	core								edge
SiO_2	35.36	38.39	38.05	38.52	38.95	38.69	38.82	38.25	38.89	39.68	39.16	38.28
FeO	38.55	21.12	27.69	21.10	18.13	21.62	18.09	22.85	19.73	18.48	19.30	22.18
MnO	0.56	0.23	0.32	0.25	0.21	0.26	0.22	0.26	0.27	0.23	0.18	0.30
NiO	0.08	0.09	0.09	0.08	0.12	0.11	0.12	0.08	0.11	0.12	0.10	0.07
MgO	25.05	37.99	33.71	39.39	40.68	37.42	40.93	37.26	41.93	42.26	41.77	36.79
CaO	0.64	0.41	0.41	0.41	0.41	0.44	0.41	0.46	0.35	0.39	0.39	0.54
Total	100.24	98.23	100.28	99.74	98.49	98.54	98.58	99.17	101.27	101.16	100.89	98.16
Cations/4 oxygen												
Si	1.000	1.012	1.013	1.000	1.009	1.018	1.005	1.007	0.988	1.001	0.995	1.015
Fe^{+2}	0.911	0.465	0.616	0.458	0.393	0.476	0.392	0.503	0.419	0.390	0.410	0.492
Mn	0.013	0.005	0.007	0.005	0.005	0.006	0.005	0.006	0.006	0.005	0.004	0.007
Ni	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Mg	1.055	1.492	1.337	1.524	1.571	1.467	1.580	1.462	1.588	1.590	1.582	1.454
Ca	0.019	0.012	0.012	0.011	0.011	0.012	0.011	0.013	0.009	0.011	0.011	0.015
Atomic ratios												
Mg	53.7	76.2	68.5	76.9	80.0	75.5	80.1	74.4	79.1	80.3	79.4	74.7
Fe^{+2}	46.3	23.8	31.5	23.1	20.0	24.5	19.9	25.6	20.9	19.7	20.6	25.3

Table 5. (continued)

	DR1-24			DR1-25		P5				P9		
	core					edge	core					
SiO_2	39.31	38.97	39.40	38.27	38.09	36.27	38.42	38.43	38.10	38.60	38.34	36.77
FeO	17.28	16.77	17.18	23.59	23.34	30.13	18.70	18.84	19.52	16.22	17.29	26.72
MnO	0.24	0.17	0.19	0.41	0.42	0.46	0.20	0.19	0.25	0.22	0.20	0.33
NiO	0.13	0.15	0.14	0.09	0.08	0.06	0.11	0.09	0.09	0.13	0.09	0.06
MgO	41.67	42.01	41.18	36.11	35.69	32.32	40.41	40.38	40.72	44.60	44.01	35.77
CaO	0.35	0.33	0.34	0.56	0.58	0.66	0.38	0.41	0.47	0.47	0.42	0.68
Total	98.98	98.40	98.43	99.02	98.21	99.90	98.22	98.34	99.14	100.23	100.35	100.32
Cations/4 oxygen												
Si	1.009	1.004	1.016	1.013	1.016	0.987	1.002	1.002	0.990	0.977	0.974	0.979
Fe^{+2}	0.371	0.361	0.370	0.522	0.520	0.685	0.408	0.410	0.424	0.343	0.367	0.595
Mn	0.005	0.004	0.004	0.009	0.010	0.011	0.005	0.004	0.005	0.005	0.004	0.007
Ni	0.003	0.003	0.003	0.002	0.002	0.001	0.002	0.002	0.002	0.003	0.002	0.001
Mg	1.594	1.614	1.582	1.425	1.419	1.310	1.571	1.569	1.576	1.683	1.667	1.419
Ca	0.010	0.009	0.009	0.016	0.017	0.019	0.011	0.012	0.013	0.013	0.011	0.019
Atomic ratios												
Mg	81.1	81.7	81.0	73.2	73.2	65.7	79.4	79.3	78.8	83.1	81.9	70.5
Fe^{+2}	18.9	18.3	19.0	26.8	26.8	34.3	20.6	20.7	21.2	16.9	18.1	29.5

Table 5. (continued)

	P27B				P36B edge	P36B core			P39 edge	P39 core		
SiO_2	38.92	38.86	39.55	38.54	37.01	38.28	38.15	38.82	36.90	36.93	37.05	37.68
FeO	14.80	14.50	12.77	15.87	27.06	15.74	21.91	17.24	27.98	26.15	27.21	20.94
MnO	0.21	0.22	0.16	0.21	0.38	0.19	0.28	0.25	0.41	0.39	0.39	0.30
NiO	0.11	0.14	0.16	0.14	0.06	0.13	0.08	0.12	0.05	0.06	0.05	0.07
MgO	46.03	45.97	47.64	45.39	35.72	45.28	40.44	44.64	35.72	36.11	35.95	41.05
CaO	0.40	0.45	0.33	0.36	0.67	0.38	0.50	0.41	0.72	0.74	0.70	0.51
Total	100.47	100.14	100.62	100.51	100.90	99.99	101.36	101.48	101.79	100.38	101.36	100.55
Cations/4 oxygen												
Si	0.976	0.977	0.980	0.972	0.981	0.970	0.980	0.975	0.974	0.980	0.978	0.973
Fe^{+2}	0.310	0.305	0.265	0.334	0.599	0.333	0.471	0.362	0.617	0.580	0.600	0.452
Mn	0.004	0.005	0.003	0.005	0.008	0.004	0.006	0.005	0.009	0.009	0.009	0.007
Ni	0.002	0.003	0.003	0.003	0.001	0.003	0.002	0.002	0.001	0.001	0.001	0.001
Mg	1.720	1.722	1.760	1.705	1.410	1.710	1.548	1.670	1.405	1.428	1.414	1.580
Ca	0.011	0.012	0.009	0.010	0.019	0.010	0.014	0.011	0.020	0.021	0.020	0.014
Atomic ratios												
Mg	84.7	85.0	86.9	83.6	70.2	83.7	76.7	82.2	69.5	71.1	70.2	77.8
Fe^{+2}	15.3	15.0	13.1	16.4	29.8	16.3	23.3	17.8	30.5	28.9	29.8	22.2

Table 5. (continued)

	P41				P48		P100				G14	
	edge	core					edge	core			edge	core
SiO_2	37.70	37.89	38.28	37.50	37.42	37.55	38.73	38.30	38.68	37.96	36.80	37.80
FeO	23.26	17.18	18.28	24.99	23.83	24.82	19.02	17.45	18.41	19.47	31.87	26.35
MnO	0.32	0.24	0.24	0.36	0.31	0.34	0.23	0.19	0.24	0.25	0.48	0.34
NiO	0.07	0.10	0.10	0.05	0.06	0.04	0.08	0.12	0.09	0.07	0.07	0.07
MgO	38.63	43.43	43.50	36.27	36.95	36.62	40.44	41.64	41.48	39.87	30.99	35.56
CaO	0.63	0.40	0.41	0.77	0.61	0.63	0.50	0.39	0.48	0.52	0.63	0.43
Total	100.71	99.24	100.82	99.94	99.17	100.01	99.01	98.08	99.39	98.15	100.82	100.55
Cations/4 oxygen												
Si	0.982	0.974	0.973	0.993	0.993	0.992	1.003	0.995	0.996	0.996	0.998	0.999
Fe^{+2}	0.509	0.369	0.388	0.553	0.528	0.548	0.412	0.379	0.396	0.427	0.722	0.582
Mn	0.007	0.005	0.005	0.008	0.007	0.008	0.005	0.004	0.005	0.006	0.011	0.008
Ni	0.002	0.002	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.001	0.002
Mg	1.500	1.664	1.648	1.431	1.461	1.442	1.561	1.613	1.592	1.559	1.252	1.400
Ca	0.018	0.011	0.011	0.022	0.017	0.018	0.014	0.011	0.013	0.015	0.018	0.012
Atomic ratios												
Mg	74.7	81.8	80.9	72.1	73.4	72.5	79.1	81.0	80.1	78.5	63.4	70.6
Fe^{+2}	25.3	18.2	19.1	27.9	26.6	27.5	20.9	19.0	19.9	21.5	36.6	29.4

Table 5. (continued)

	G14 edge	G14 core			G115B			G142A		G201A	
SiO_2	36.53	38.54	34.73	35.16	39.07	37.38	38.64	38.86	38.27	38.46	38.44
FeO	33.34	18.10	43.66	40.88	18.29	28.29	19.66	16.33	17.29	16.55	15.25
MnO	0.48	0.20	0.80	0.62	0.19	0.31	0.20	0.24	0.25	0.23	0.18
NiO	0.08	0.11	0.08	0.07	0.10	0.08	0.09	0.10	0.09	0.11	0.14
MgO	30.35	42.26	20.91	23.74	41.90	33.10	40.35	43.22	41.69	42.61	43.95
CaO	0.62	0.39	0.97	0.74	0.39	0.56	0.41	0.47	0.52	0.34	0.28
Total	101.41	99.60	101.13	101.21	99.93	99.72	99.35	99.22	98.10	98.30	98.24
Cations/4 oxygen											
Si	0.992	0.989	1.000	0.996	0.998	1.006	1.000	0.993	0.994	0.993	0.988
Fe^{+2}	0.757	0.388	1.051	0.968	0.391	0.636	0.426	0.349	0.375	0.357	0.328
Mn	0.011	0.004	0.019	0.015	0.004	0.007	0.004	0.005	0.006	0.005	0.004
Ni	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003
Mg	1.228	1.616	0.898	1.002	1.596	1.327	1.557	1.646	1.614	1.640	1.683
Ca	0.018	0.011	0.030	0.023	0.011	0.016	0.011	0.013	0.014	0.010	0.008
Atomic ratios											
Mg	61.9	80.6	46.1	50.9	80.3	67.6	78.5	82.5	81.1	82.1	83.7
Fe^{+2}	38.1	19.4	53.9	49.1	19.7	32.4	21.5	17.5	18.9	17.9	16.3

Table 6. Electron microprobe data for pyroxenes.
Analyses by F. Lee-Wong.

	DR5-4			DR5-34		DR5-57	DR5-83		DR5-100			
SiO_2	52.41	51.47	52.50	49.79	50.69	52.10	47.59	49.57	49.53	49.37	50.05	49.13
TiO	0.87	0.98	1.08	0.83	0.89	0.56	2.14	2.26	1.19	1.11	1.22	1.20
Al_2O_3	3.28	3.95	2.07	3.73	3.45	2.11	6.70	4.78	3.95	3.19	3.41	4.09
Cr_2O_3	0.43	0.45	0.38	0.24	0.25	0.21	0.16	0.26	0.17	0.17	0.14	0.16
FeO	6.86	6.49	7.98	8.48	9.16	8.21	7.09	8.24	9.80	11.44	10.73	10.69
MnO	0.15	0.15	0.18	0.19	0.21	0.19	0.13	0.15	0.19	0.23	0.20	0.22
MgO	17.26	16.49	16.68	13.36	13.84	14.91	12.35	12.83	13.04	12.79	13.51	12.88
CaO	19.45	20.70	20.71	20.91	21.24	21.11	22.97	23.09	20.49	19.63	21.09	19.48
Na_2O	0.37	0.36	0.29	0.35	0.39	0.37	0.47	0.43	0.40	0.47	0.38	0.47
Total	101.07	101.03	101.86	97.86	100.12	99.77	99.60	101.61	98.77	98.40	100.73	98.32
Cations/6 oxygen												
Si	1.903	1.876	1.910	1.896	1.892	1.939	1.785	1.829	1.879	1.892	1.872	1.876
Al^{iv}	0.097	0.124	0.089	0.104	0.108	0.061	0.215	0.171	0.121	0.108	0.128	0.124
Al^{vi}	0.044	0.046	0.000	0.064	0.045	0.032	0.083	0.038	0.057	0.037	0.023	0.061
Ti	0.024	0.027	0.030	0.024	0.025	0.016	0.060	0.063	0.034	0.032	0.034	0.035
Cr	0.012	0.013	0.011	0.007	0.008	0.006	0.005	0.008	0.005	0.005	0.004	0.005
Fe^{+2}	0.208	0.198	0.243	0.270	0.286	0.255	0.222	0.254	0.311	0.367	0.335	0.341
Mn	0.005	0.005	0.005	0.006	0.007	0.006	0.004	0.005	0.006	0.008	0.006	0.007
Mg	0.934	0.896	0.905	0.758	0.770	0.827	0.690	0.706	0.737	0.731	0.754	0.733
Ca	0.757	0.808	0.807	0.853	0.850	0.841	0.923	0.913	0.833	0.806	0.845	0.797
Na	0.026	0.026	0.020	0.026	0.028	0.027	0.034	0.031	0.030	0.035	0.028	0.034
Atomic ratios												
Ca	39.8	42.5	41.3	45.3	44.6	43.7	50.3	48.7	44.3	42.3	43.7	42.6
Mg	49.2	47.1	46.3	40.3	40.4	43.0	37.6	37.7	39.2	38.4	39.0	39.2
Fe^{+2}	11.0	10.4	12.4	14.3	15.0	13.3	12.1	13.6	16.5	19.3	17.3	18.2

Table 6. (continued)

	DR5-121		DR1-24			DR1-25				DR1-27		
SiO_2	50.85	50.34	50.25	51.64	52.28	46.25	47.76	49.78	47.81	50.30	49.05	51.09
TiO	0.91	0.93	0.95	1.56	1.42	2.78	1.92	1.84	1.99	0.48	2.45	1.07
Al_2O_3	2.77	2.86	2.73	1.96	2.13	6.52	4.73	4.13	5.97	3.36	4.32	4.51
Cr_2O_3	0.19	0.22	0.25	0.23	0.22	0.26	0.25	0.30	0.21	0.17	0.22	0.32
FeO	10.36	9.77	9.93	10.96	10.33	9.68	8.26	7.54	9.05	7.52	10.62	7.17
MnO	0.23	0.21	0.20	0.23	0.23	0.17	0.17	0.18	0.17	0.13	0.23	0.14
MgO	13.08	13.69	12.42	12.12	13.57	12.24	12.20	13.68	11.76	13.72	11.95	15.07
CaO	20.67	21.47	21.74	21.15	20.84	22.76	24.52	23.42	22.19	21.44	21.09	22.21
Na_2O	0.37	0.36	0.35	0.40	0.39	0.67	0.60	0.59	0.69	0.40	0.51	0.43
Total	99.43	99.86	98.82	100.26	101.42	101.33	100.42	101.47	99.84	97.52	100.46	102.01
Cations/6 oxygen												
Si	1.918	1.894	1.912	1.938	1.931	1.734	1.800	1.838	1.803	1.914	1.843	1.859
Al^{iv}	0.082	0.106	0.088	0.062	0.069	0.266	0.200	0.162	0.197	0.086	0.157	0.141
Al^{vi}	0.042	0.022	0.035	0.025	0.024	0.023	0.011	0.019	0.070	0.066	0.035	0.053
Ti	0.026	0.026	0.027	0.044	0.039	0.078	0.055	0.051	0.056	0.014	0.069	0.029
Cr	0.006	0.007	0.008	0.007	0.007	0.008	0.008	0.009	0.006	0.005	0.007	0.009
Fe^{+2}	0.327	0.307	0.316	0.344	0.319	0.303	0.260	0.233	0.285	0.239	0.334	0.218
Mn	0.007	0.007	0.006	0.007	0.007	0.005	0.006	0.006	0.005	0.004	0.007	0.004
Mg	0.735	0.767	0.705	0.678	0.747	0.684	0.686	0.753	0.661	0.778	0.669	0.817
Ca	0.836	0.865	0.886	0.851	0.825	0.914	0.990	0.926	0.897	0.874	0.849	0.866
Na	0.027	0.027	0.026	0.029	0.028	0.049	0.044	0.042	0.051	0.030	0.037	0.030
Atomic ratios												
Ca	44.0	44.6	46.5	45.4	43.6	48.1	51.1	48.5	48.6	46.2	45.8	45.5
Mg	38.7	39.6	37.0	36.2	39.5	36.0	35.4	39.4	35.9	41.1	36.1	43.0
Fe^{+2}	17.2	15.8	16.6	18.4	16.9	16.0	13.4	12.2	15.5	12.7	18.0	11.5

Table 6. (continued)

	DR1-27	P5		P27B		P36B	P39		P41			P48
SiO_2	51.11	49.52	49.39	50.05	47.97	49.14	48.70	49.09	49.10	48.74	47.63	45.59
TiO_2	1.21	1.77	2.13	0.65	1.04	1.03	0.83	1.13	2.16	1.71	2.84	3.22
Al_2O_3	4.38	3.54	4.09	5.87	5.84	3.92	4.83	3.97	4.36	5.60	4.81	6.82
Cr_2O_3	0.29	0.25	0.22	0.34	0.18	0.14	0.19	0.19	0.30	0.36	0.17	0.26
FeO	7.57	9.14	7.55	4.94	6.87	7.25	6.74	8.14	8.79	7.18	10.20	8.78
MnO	0.16	0.17	0.16	0.11	0.16	0.14	0.12	0.20	0.19	0.13	0.19	0.14
MgO	14.52	13.66	13.74	14.73	12.65	13.33	13.27	11.87	12.70	14.09	12.58	11.51
CaO	21.41	22.26	21.74	22.04	23.02	22.25	21.96	23.21	22.42	21.74	21.11	22.46
Na_2O	0.44	0.43	0.46	0.59	0.51	0.29	0.45	0.37	0.55	0.47	0.48	0.54
Total	101.09	100.75	99.47	99.33	98.22	97.49	97.09	98.18	100.57	100.02	100.01	99.32
Cations/6 oxygen												
Si	1.874	1.849	1.851	1.851	1.823	1.877	1.862	1.876	1.835	1.814	1.800	1.736
Al^{iv}	0.126	0.151	0.149	0.149	0.177	0.123	0.138	0.124	0.165	0.186	0.200	0.264
Al^{vi}	0.064	0.006	0.033	0.108	0.086	0.054	0.081	0.056	0.028	0.061	0.015	0.043
Ti	0.033	0.050	0.060	0.018	0.030	0.030	0.024	0.032	0.061	0.048	0.081	0.092
Cr	0.009	0.007	0.007	0.010	0.005	0.004	0.006	0.006	0.009	0.011	0.005	0.008
Fe^{+2}	0.232	0.285	0.236	0.153	0.218	0.232	0.215	0.260	0.275	0.223	0.322	0.279
Mn	0.005	0.005	0.005	0.004	0.005	0.004	0.004	0.006	0.006	0.004	0.006	0.005
Mg	0.794	0.760	0.767	0.812	0.716	0.759	0.756	0.676	0.708	0.781	0.709	0.653
Ca	0.841	0.891	0.873	0.873	0.937	0.910	0.900	0.950	0.898	0.867	0.855	0.916
Na	0.031	0.031	0.033	0.043	0.037	0.021	0.034	0.028	0.040	0.034	0.035	0.040
Atomic ratios												
Ca	45.1	46.0	46.5	47.5	50.1	47.9	48.1	50.4	47.8	46.3	45.3	49.6
Mg	42.5	39.3	40.9	44.2	38.3	39.9	40.4	35.8	37.6	41.8	37.6	35.3
Fe^{+2}	12.4	14.7	12.6	8.3	11.7	12.2	11.5	13.8	14.6	11.9	17.1	15.1

Table 6. (continued)

		G14		G115B				G201A	
SiO_2	44.78	50.46	51.15	50.59	52.08	50.48	49.91	50.27	50.54
TiO	3.40	1.01	1.00	0.73	0.60	0.88	0.93	1.02	0.82
Al_2O_3	7.32	2.61	2.72	2.60	2.04	2.79	1.89	2.44	2.77
Cr_2O_3	0.22	0.23	0.31	0.17	0.21	0.19	0.15	0.26	0.16
FeO	9.89	8.40	8.49	9.86	9.11	10.19	15.69	12.92	10.68
MnO	0.15	0.16	0.15	0.21	0.18	0.21	0.32	0.25	0.21
MgO	11.50	13.57	12.92	14.93	15.76	14.10	10.96	11.15	13.33
CaO	21.97	22.18	22.13	19.51	18.96	19.81	18.97	20.35	20.41
Na_2O	0.53	0.44	0.43	0.28	0.24	0.34	0.36	0.41	0.36
Total	99.75	99.05	99.31	98.87	99.18	98.99	99.20	99.06	99.28
Cations/6 oxygen									
Si	1.706	1.905	1.923	1.910	1.944	1.909	1.930	1.927	1.912
Al^{iv}	0.294	0.095	0.077	0.090	0.056	0.091	0.070	0.073	0.088
Al^{vi}	0.036	0.022	0.044	0.026	0.034	0.034	0.017	0.038	0.036
Ti	0.097	0.029	0.028	0.021	0.017	0.025	0.027	0.029	0.023
Cr	0.007	0.007	0.009	0.005	0.006	0.006	0.005	0.008	0.005
Fe^{+2}	0.315	0.265	0.267	0.311	0.284	0.322	0.507	0.414	0.338
Mn	0.005	0.005	0.005	0.007	0.006	0.007	0.011	0.008	0.007
Mg	0.653	0.764	0.724	0.840	0.877	0.795	0.632	0.637	0.752
Ca	0.897	0.897	0.891	0.789	0.758	0.802	0.786	0.836	0.827
Na	0.039	0.032	0.032	1.021	0.017	0.025	0.027	0.030	0.026
Atomic ratios									
Ca	48.1	46.6	47.4	40.7	39.5	41.8	40.8	44.3	43.2
Mg	35.0	39.6	38.5	43.3	45.7	41.4	32.8	33.8	39.2
Fe^{+2}	16.9	13.8	14.2	16.0	14.8	16.8	26.4	21.9	17.6

Table 7. Electron microprobe data for opaque minerals. Fe^{+2} and Fe^{+3} in magnetite were recalculated with an ulvospinal molecule (Carmichael, 1967). Analyses by F. Lee-Wong.

	DR5-34 Ti mgnt	DR5-34 Ti mgnt	DR1-25 Ti mgnt	P5 Ti mgnt	P27E Ti mgnt	P39 Ti mgnt	P39 Ti mgnt	P41 Ti mgnt	P48 Ti mgnt	G142A Ti mgnt
SiO_2	0.87	2.34	0.58	0.87	0.62	0.69	0.65	0.71	0.68	1.45
TiO_2	25.03	25.79	21.35	30.71	27.94	29.65	29.37	26.55	27.38	17.75
Al_2O_3	1.25	1.31	5.30	1.36	2.98	3.14	3.24	2.88	3.53	6.31
Cr_2O_3	3.76	1.83	1.75	1.67	1.78	1.84	1.67	1.58	1.67	1.49
Fe_2O_3	14.64	11.82	18.52	4.95	8.30	5.53	5.64	10.81	7.77	22.78
FeO	56.24	59.14	52.73	61.15	58.41	60.47	60.09	57.02	57.67	50.77
Total	101.80	102.24	100.23	100.71	100.03	101.32	100.66	99.55	98.69	100.54
Cations/32 oxygen										
Si	0.245	0.922	0.175	0.247	0.176	0.193	0.192	0.213	0.196	0.211
Ti	5.491	5.604	4.674	6.781	6.181	6.451	6.442	5.906	6.112	3.903
Al	0.421	0.451	1.821	0.459	1.024	1.078	1.120	0.996	1.247	2.180
Cr	0.877	0.417	0.420	0.389	0.424	0.417	0.385	0.356	0.392	0.351
Fe^{+3}	3.228	2.568	4.061	1.095	1.837	1.217	1.225	2.419	1.747	5.028
Fe^{+2}	13.737	14.279	12.849	15.029	14.358	14.642	14.634	14.107	14.309	12.429

Table 7. (continued)

	DR5-4 ilmenite	DR5-34 ilmenite	DR5-57 ilmenite	P5 ilmenite	G115B ilmenite
SiO_2	1.40	0.70	0.48	0.59	0.81
TiO_2	50.78	50.58	52.59	52.34	49.90
Al_2O_3	0.09	0.05	0.08	0.01	0.03
Cr_2O_3	1.64	1.56	1.33	1.77	1.67
FeO	47.34	47.71	45.43	46.08	48.35
Total	101.25	100.60	99.92	100.80	100.76
Cations/6 oxygen					
Si	0.070	0.035	0.024	0.030	0.041
Ti	1.896	1.913	1.981	1.959	1.890
Al	0.005	0.003	0.005	0.000	0.002
Cr	0.065	0.063	0.053	0.070	0.067
Fe^{+2}	1.965	2.006	1.903	1.917	2.036

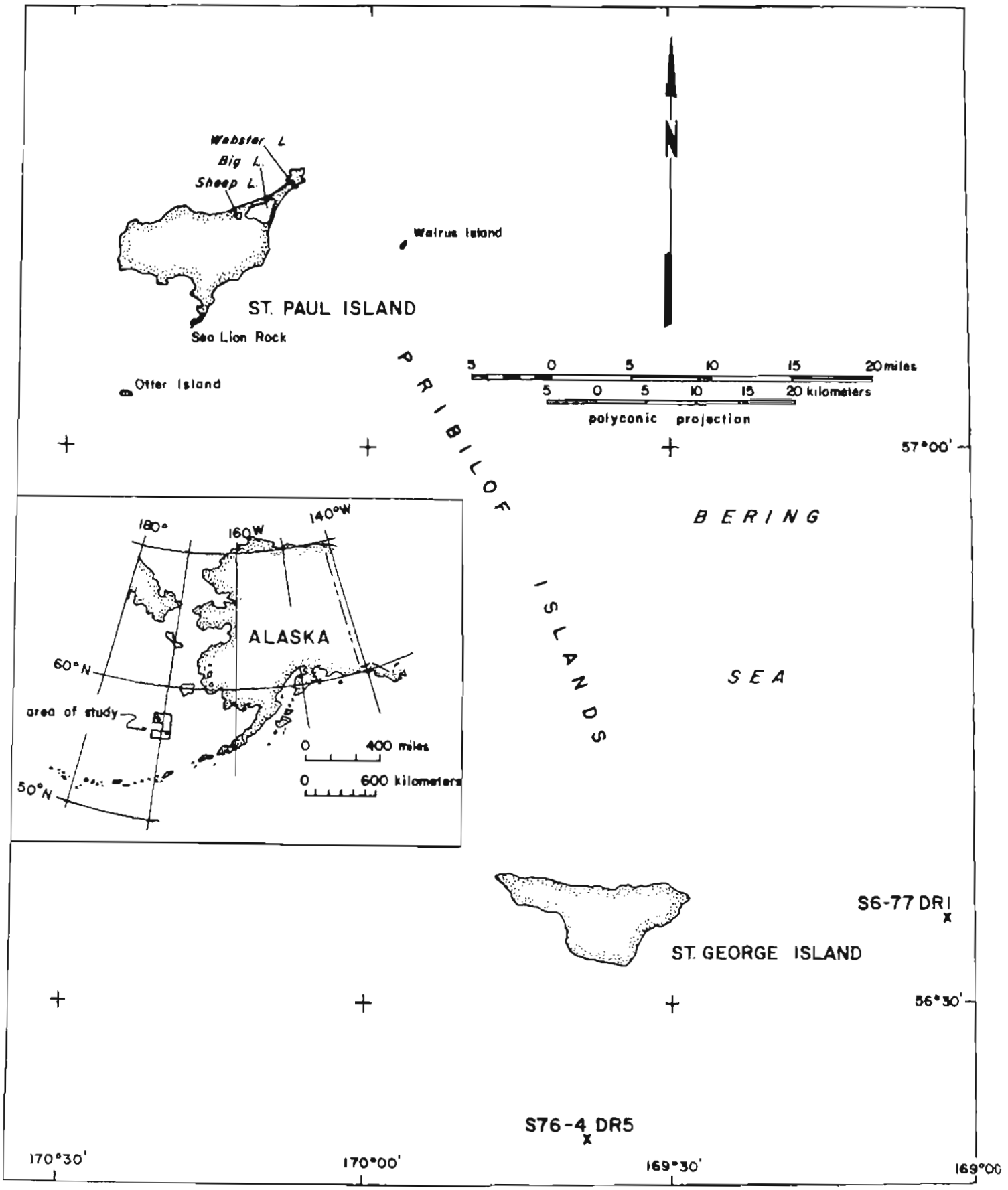


Figure 1. Location map of the Pribilof Islands and U. S. Geological Survey dredge sites S76-4 and S6-77.

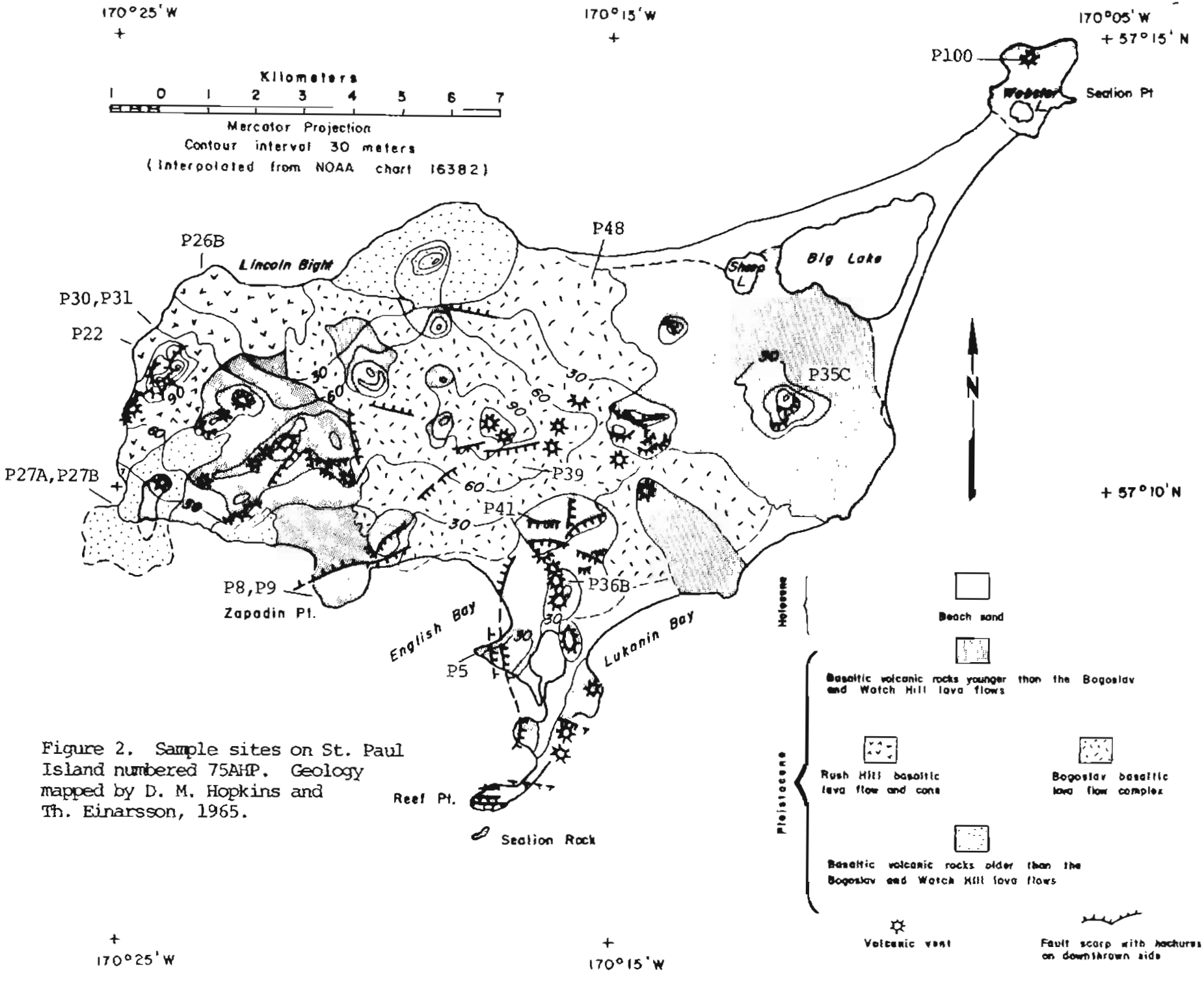
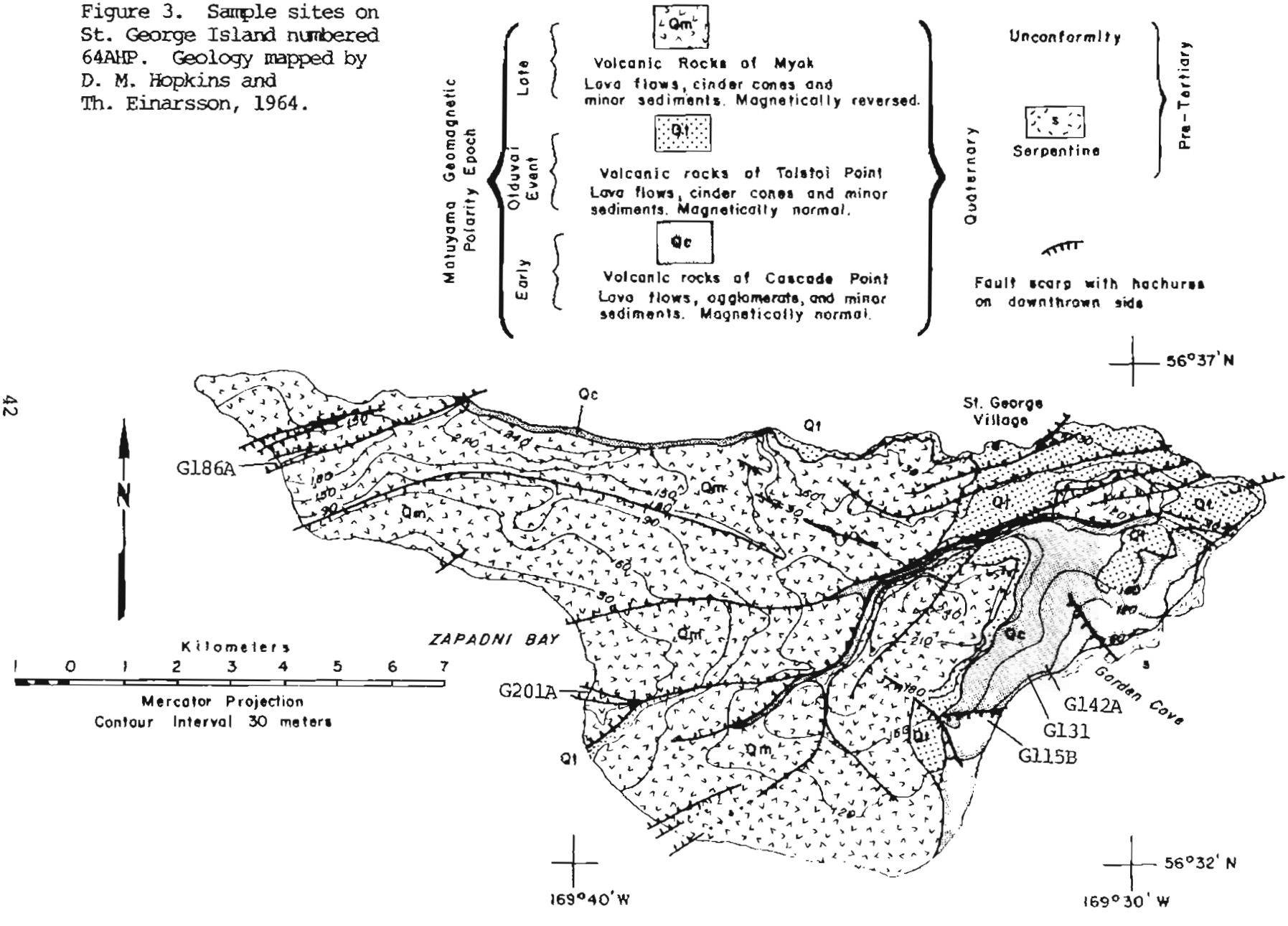


Figure 2. Sample sites on St. Paul Island numbered 75AHP. Geology mapped by D. M. Hopkins and Th. Einarsson, 1965.

Figure 3. Sample sites on St. George Island numbered 64AHP. Geology mapped by D. M. Hopkins and Th. Einarsson, 1964.



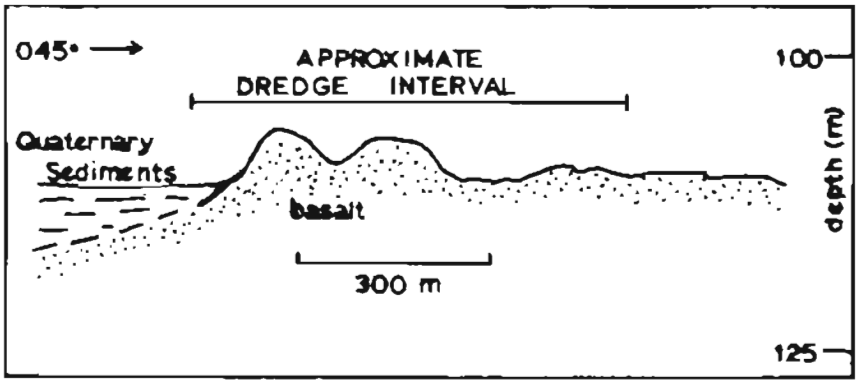


Figure 4. Dredge site S76-4 DR5.

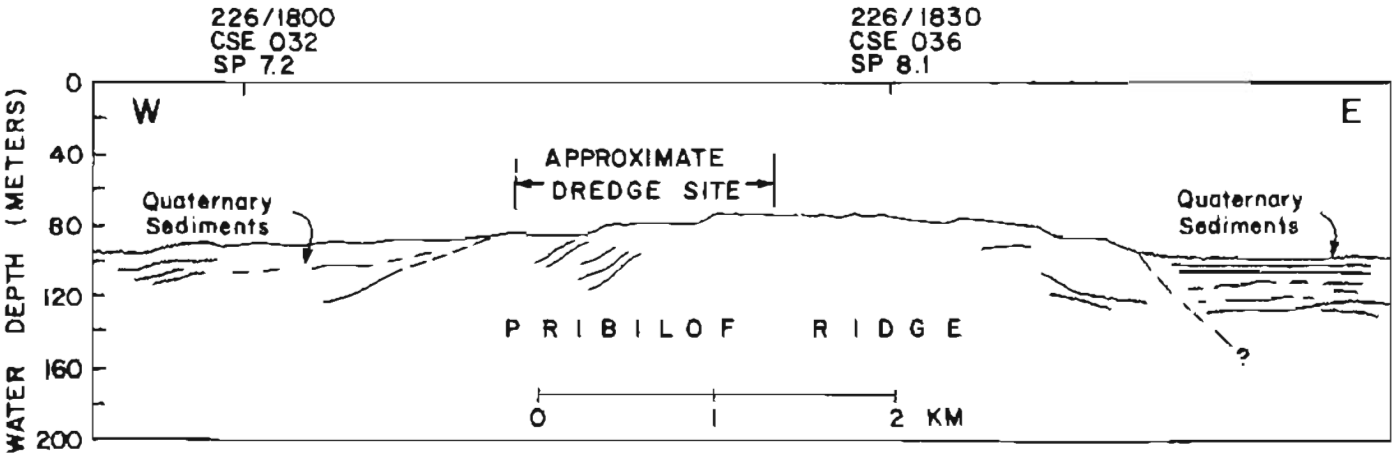


Figure 5. Dredge site S77-6 DR1.

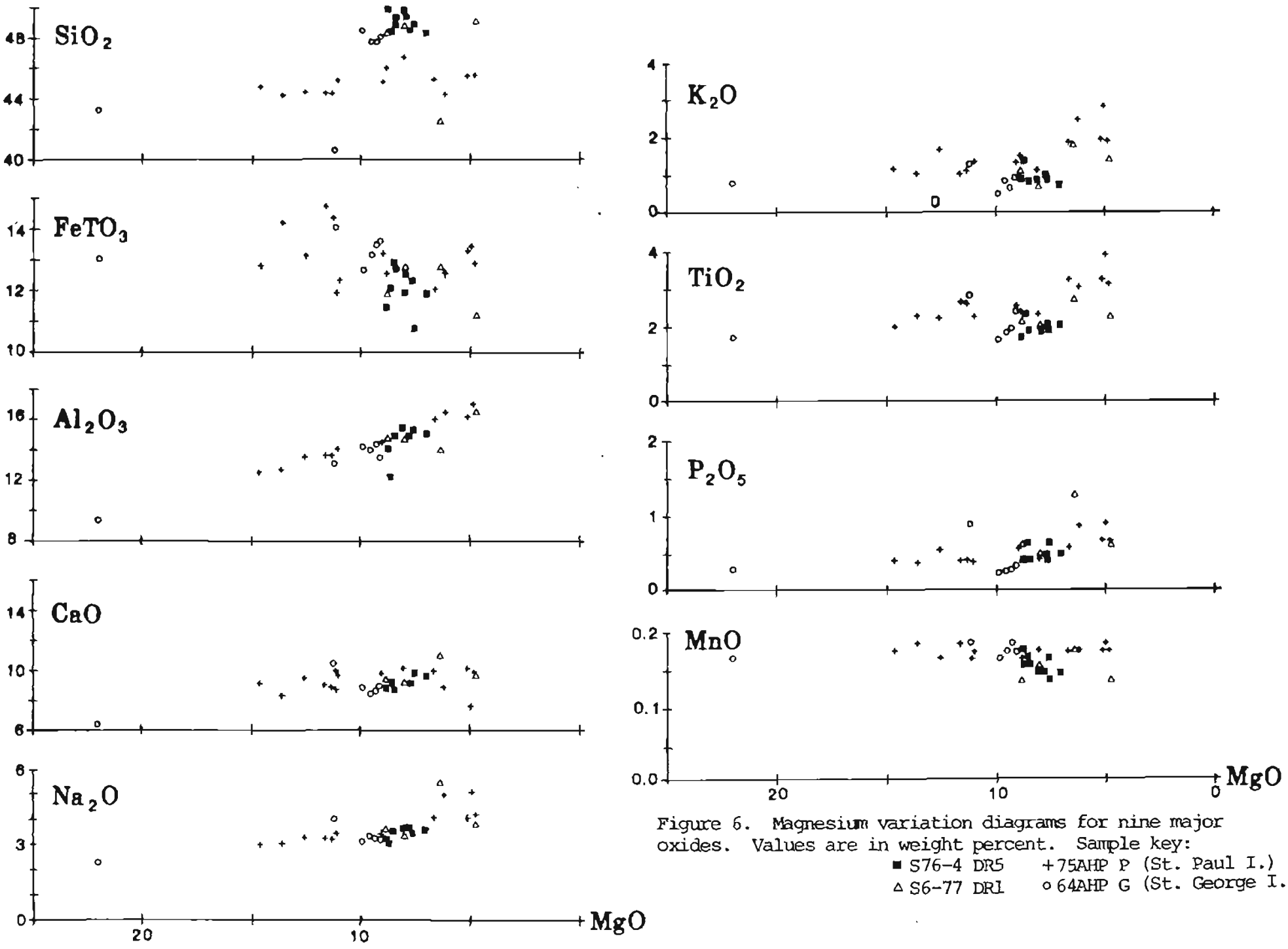


Figure 6. Magnesium variation diagrams for nine major oxides. Values are in weight percent. Sample key:

■ S76-4 DR5 + 75AHP P (St. Paul I.)
△ S6-77 DR1 ○ 64AHP G (St. George I.)

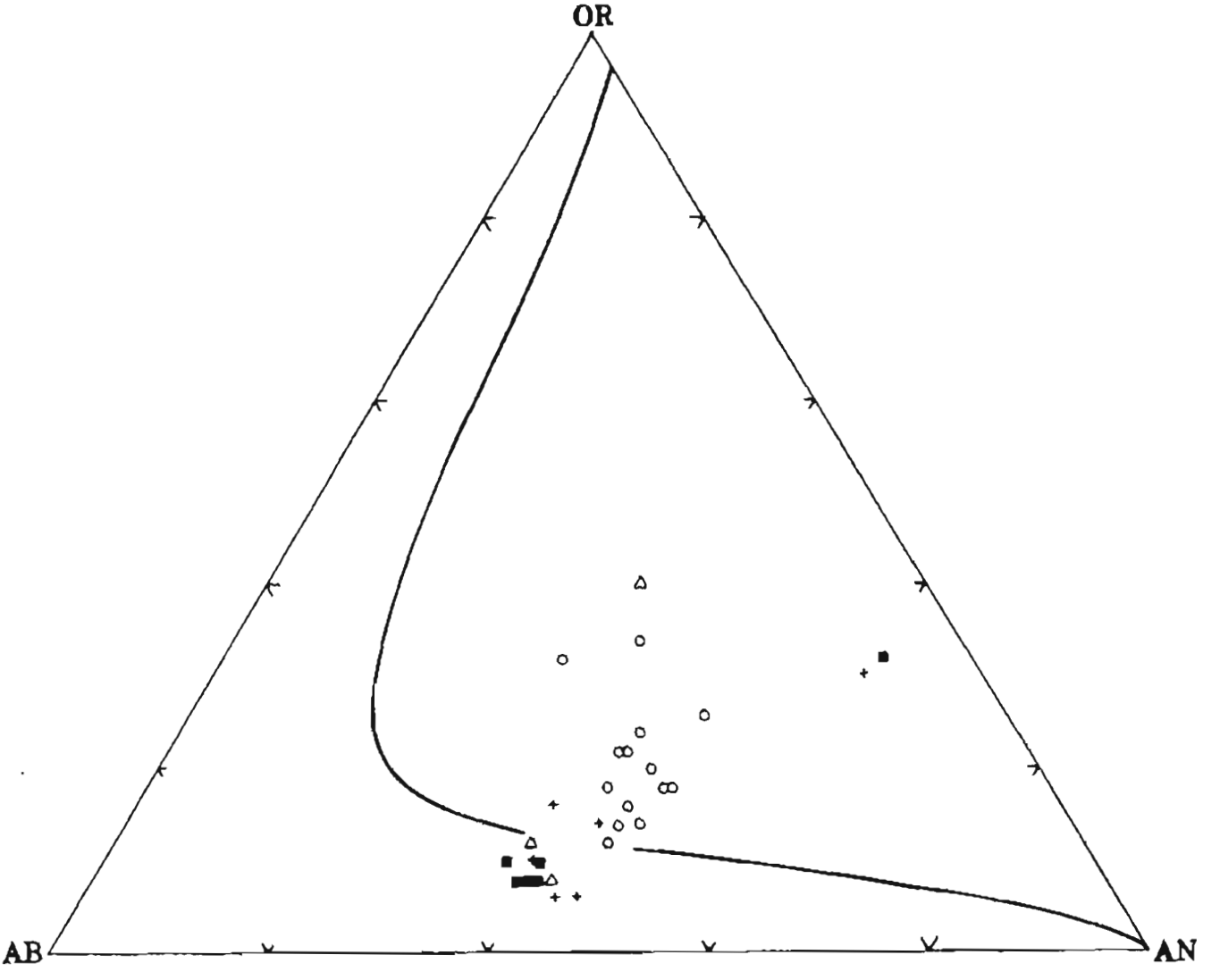


Figure 7. Ternary plot of molecular proportions of normative feldspars. Symbols defined in Figure 6.

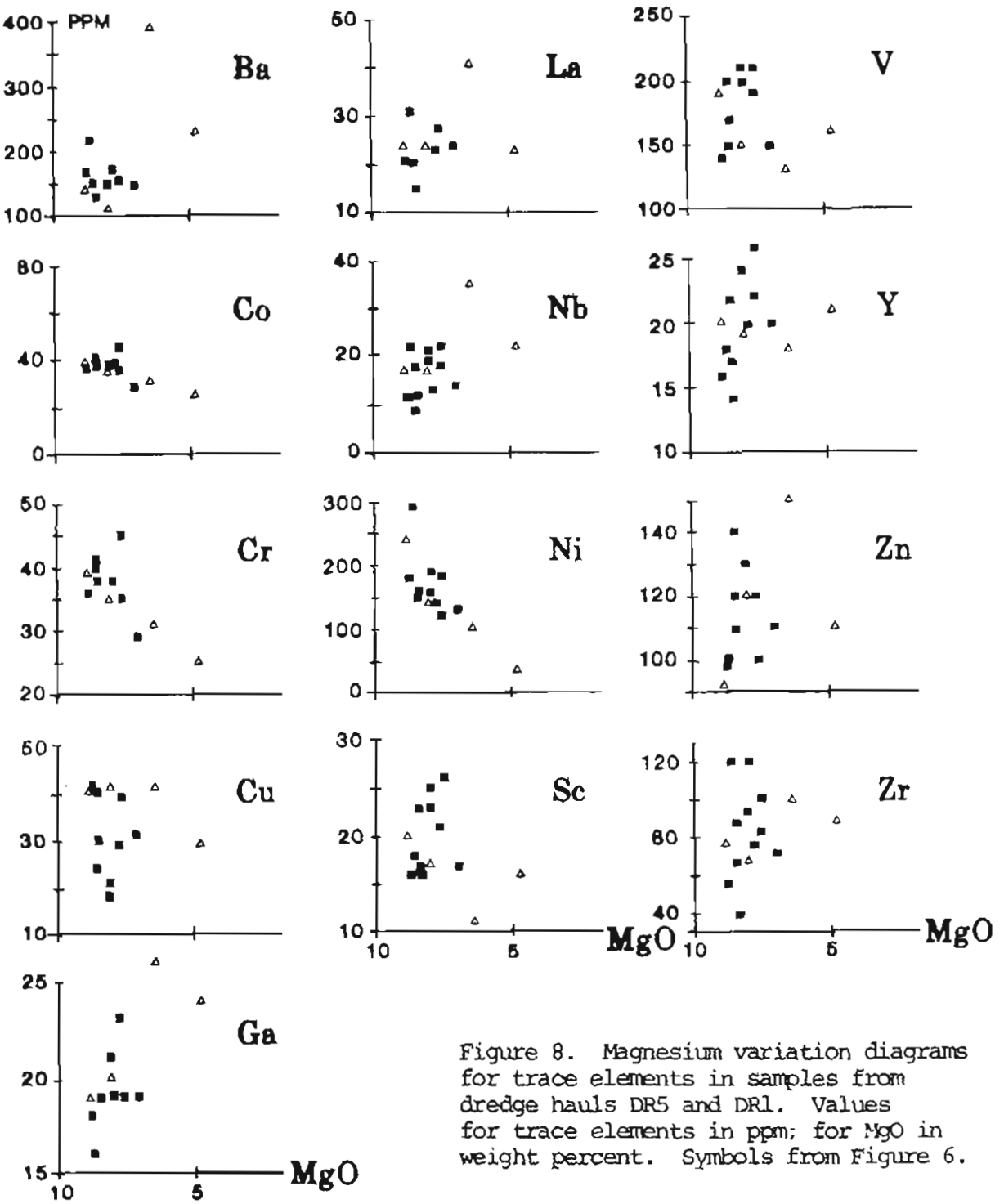


Figure 8. Magnesium variation diagrams for trace elements in samples from dredge hauls DR5 and DR1. Values for trace elements in ppm; for MgO in weight percent. Symbols from Figure 6.

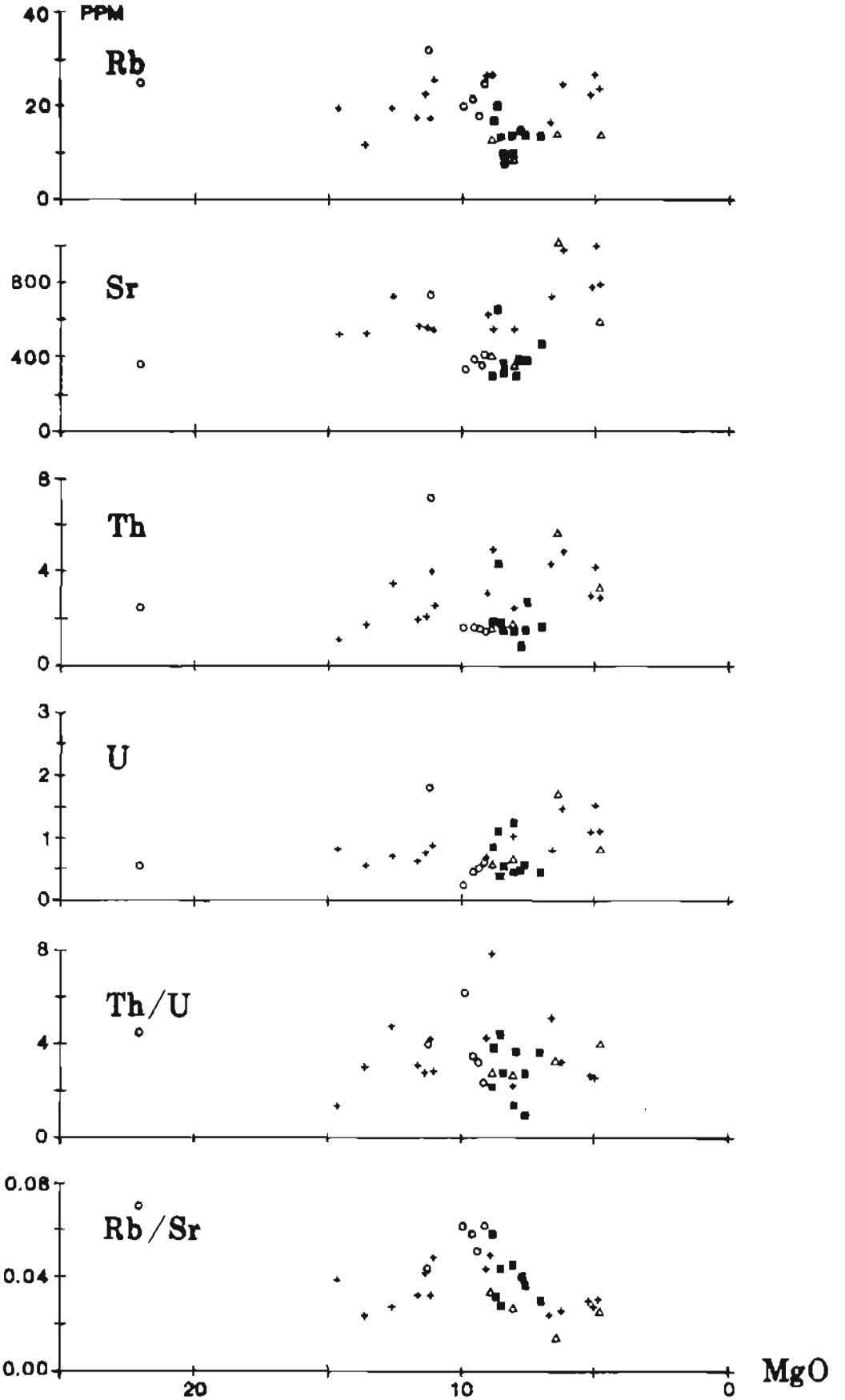


Figure 9. Magnesium variation diagrams for Rb, Sr, Th, U, Th/U and Rb/Sr. Units for trace elements are ppm; for MgO, weight percent. Symbols from Figure 6.

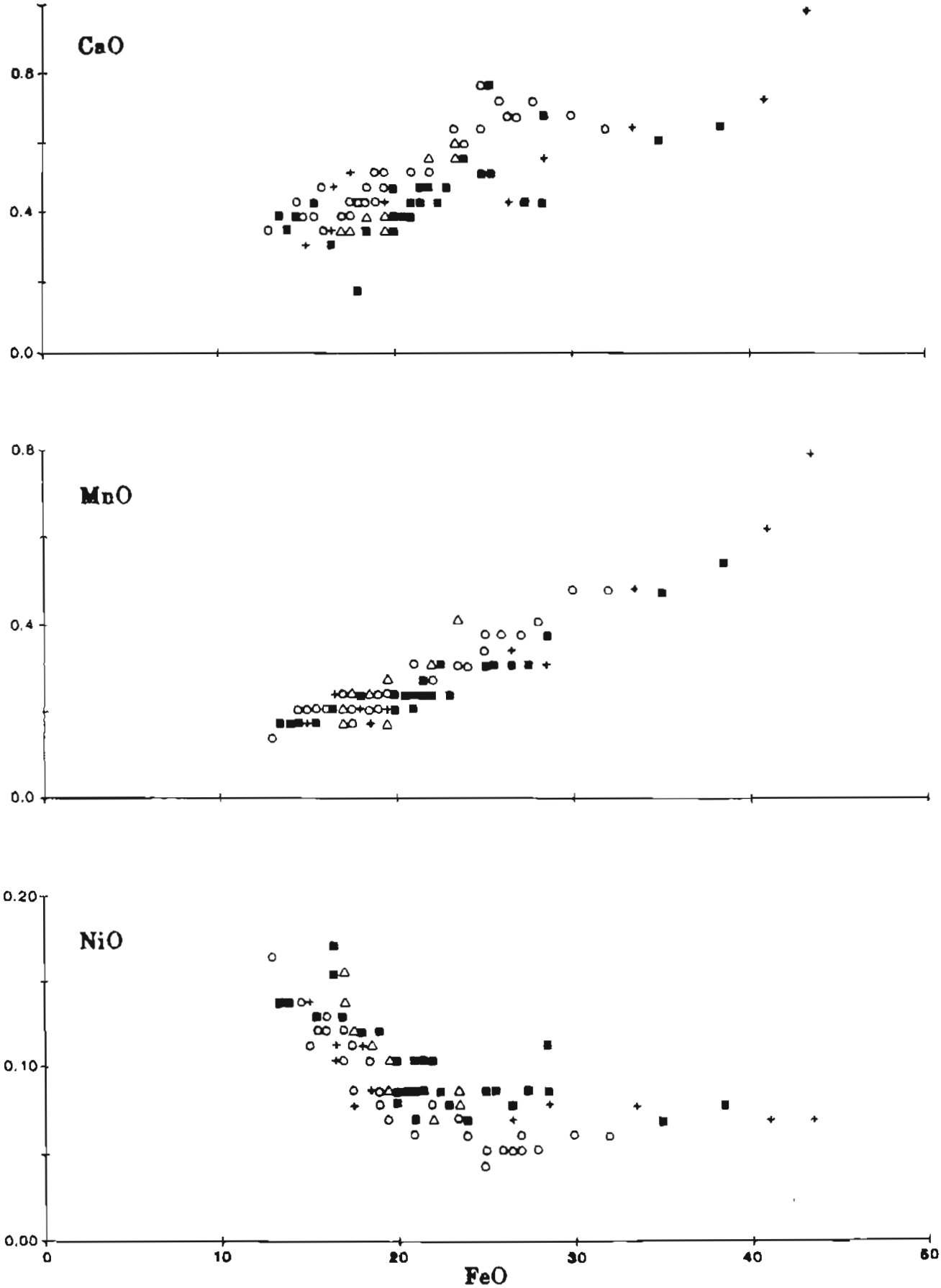


Figure 10. FeO variation diagrams for electron microprobe analyses of olivine. Values given in weight percent. Symbols from Figure 6.

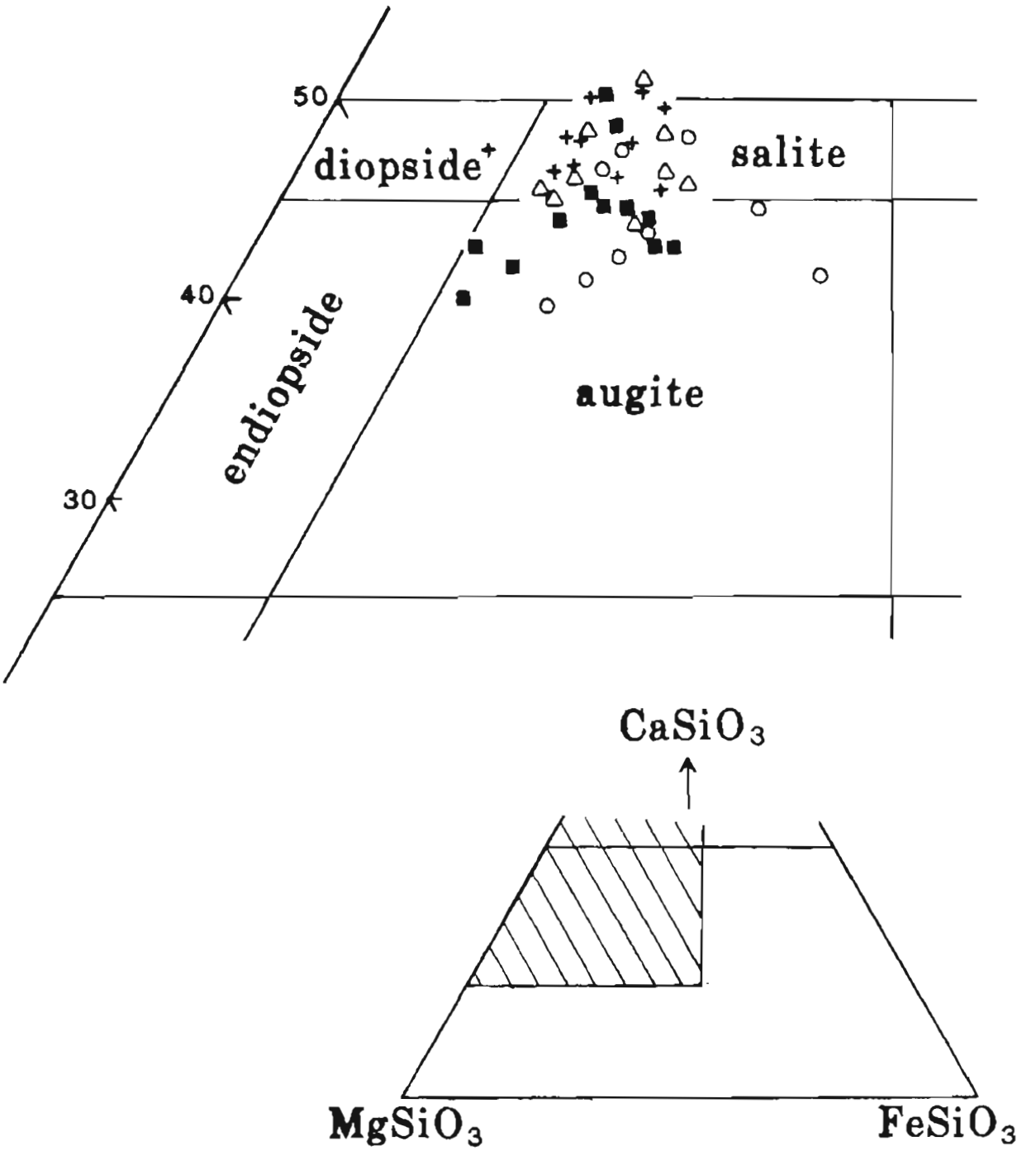


Figure 11. Ternary diagram of electron microprobe analyses of pyroxene normalized from molecular proportions. Fields defined by Poldervaart and Hess (1951). Symbols from Figure 6.

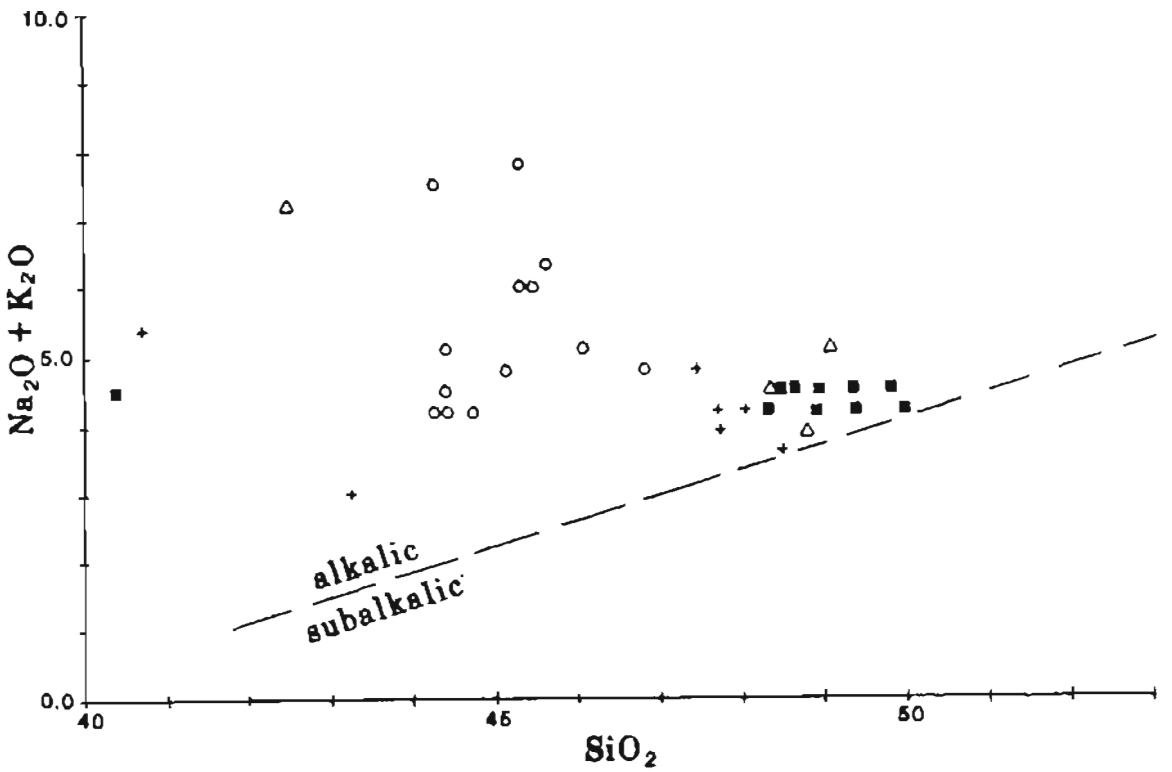


Figure 12. Alkali-silica plot of data from the Pribilof Islands and dredge hauls. Values are given in weight percent. Fields defined by MacDonald and Katsura (1964). Symbols from Figure 6.

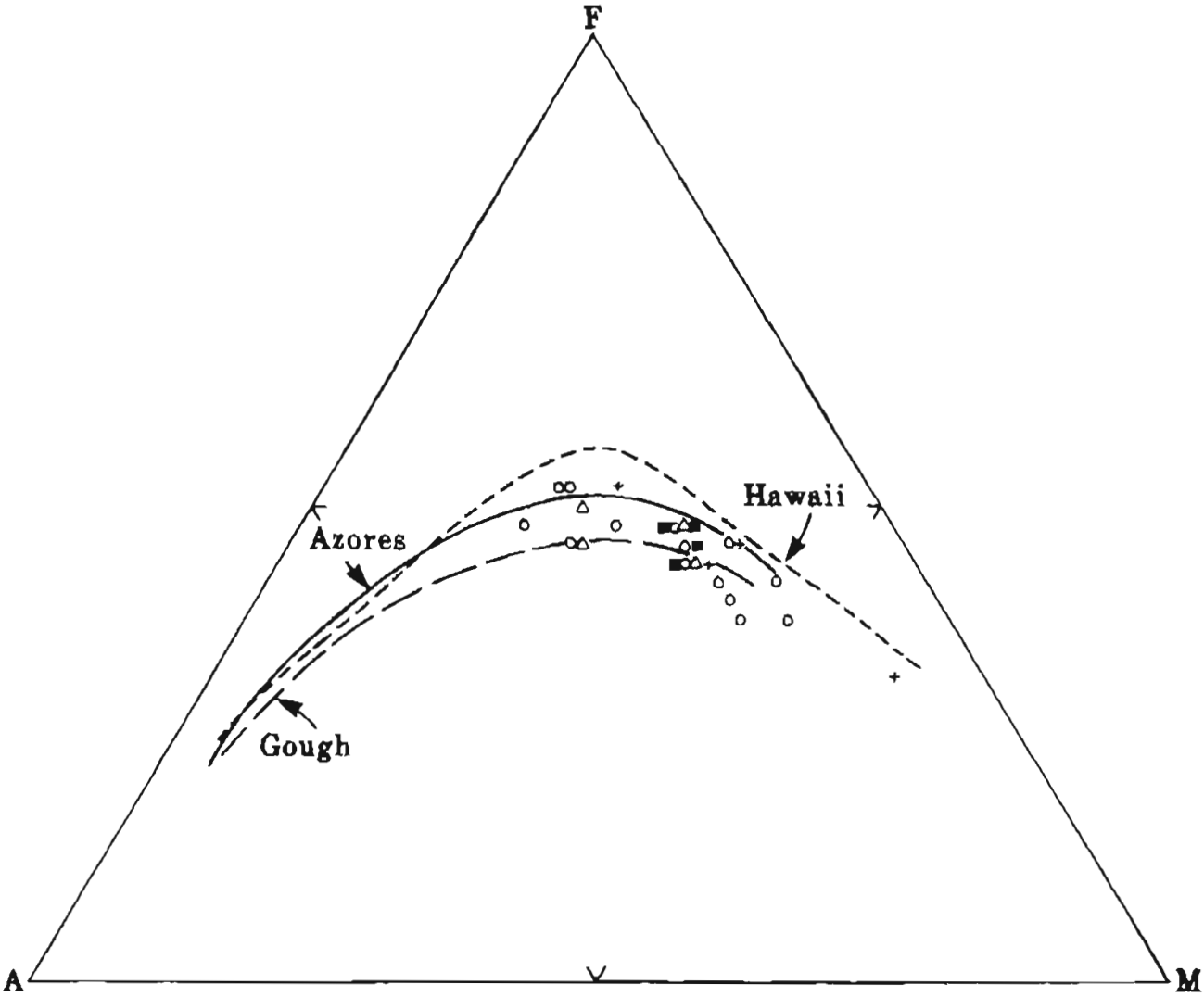


Figure 13. Ternary plot of F (total iron as FeO), A (alkalis $K_2O + Na_2O$), and M (MgO) normalized from weight percent data. Trends of other alkalic oceanic island groups are also included. Azores and Gough Island data from LeMaitre (1962); Hawaiian Islands data from MacDonald and Katsura (1964). Symbols from Figure 6.

Table 5. Electron microprobe data for olivines.
Analyses by F. Lee-Wong.

	DR5-4			DR5-8				DR5-32				DR5-34
SiO_2	38.21	38.20	38.52	38.91	38.82	38.98	39.27	39.13	39.91	38.99	39.29	38.53
FeO	19.36	25.68	20.20	20.51	19.83	19.83	16.32	17.23	16.48	17.11	17.63	21.85
MnO	0.26	0.33	0.25	0.24	0.23	0.24	0.20	0.20	0.21	0.20	0.21	0.25
NiO	0.11	0.09	0.10	0.10	0.09	0.09	0.15	0.13	0.17	0.14	0.13	0.10
MgO	39.99	35.12	39.56	40.72	41.91	41.10	42.88	41.17	43.19	42.27	41.75	37.76
CaO	0.41	0.76	0.47	0.39	0.40	0.37	0.32	0.34	0.33	0.34	0.42	0.47
Total	98.34	100.18	99.10	100.86	101.27	100.60	99.14	98.21	100.30	99.06	99.43	98.96
Cations/4 oxygen												
Si	0.999	1.009	1.003	0.995	0.987	0.997	1.002	1.012	1.006	1.000	1.006	1.011
Fe^{+2}	0.423	0.567	0.439	0.439	0.421	0.424	0.348	0.372	0.347	0.367	0.377	0.479
Mn	0.006	0.007	0.006	0.005	0.005	0.005	0.004	0.004	0.005	0.004	0.005	0.006
Ni	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.002
Mg	1.559	1.383	1.535	1.553	1.588	1.566	1.631	1.587	1.623	1.616	1.593	1.477
Ca	0.011	0.022	0.013	0.011	0.011	0.010	0.009	0.010	0.009	0.009	0.011	0.013
Atomic ratios												
Mg	78.6	70.9	77.7	78.0	79.0	78.7	82.4	81.0	82.4	81.5	80.9	75.5
Fe^{+2}	21.4	29.1	22.3	22.0	21.0	21.3	17.6	19.0	17.6	18.5	19.1	24.5

Table 5. (continued)

	DR5-34			DR5-57				DR5-83				
					core	edge						
SiO_2	37.58	38.54	38.95	38.47	37.86	36.72	37.27	39.77	39.67	39.15	39.74	39.23
FeO	28.57	25.16	21.62	28.68	26.60	34.83	28.54	13.80	15.36	13.42	14.65	18.23
MnO	0.39	0.31	0.28	0.33	0.32	0.49	0.38	0.17	0.16	0.18	0.17	0.24
NiO	0.11	0.10	0.11	0.10	0.08	0.08	0.08	0.15	0.14	0.15	0.14	0.12
MgO	33.93	36.67	39.29	33.08	35.17	27.92	33.26	45.13	45.09	44.47	45.62	42.95
CaO	0.68	0.53	0.45	0.45	0.42	0.62	0.55	0.34	0.43	0.38	0.38	0.16
Total	101.26	101.31	100.70	101.11	100.46	100.65	100.08	99.36	100.84	97.75	100.71	100.94
Cations/4 oxygen												
Si	0.997	1.003	1.003	1.019	1.002	1.011	1.001	1.001	0.991	1.001	0.991	0.992
Fe^{+2}	0.634	0.548	0.465	0.635	0.588	0.802	0.641	0.290	0.321	0.287	0.305	0.385
Mn	0.009	0.007	0.006	0.007	0.007	0.012	0.009	0.004	0.003	0.004	0.004	0.005
Ni	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.002
Mg	1.342	1.423	1.508	1.306	1.387	1.146	1.331	1.693	1.679	1.694	1.696	1.619
Ca	0.019	0.015	0.012	0.013	0.012	0.018	0.016	0.009	0.011	0.010	0.010	0.004
Atomic ratios												
Mg	67.9	72.2	76.4	67.3	70.2	58.8	67.5	85.4	84.0	85.5	84.7	80.8
Fe^{+2}	32.1	27.8	23.6	32.7	29.8	41.2	32.5	14.6	16.0	14.5	15.3	19.2

Table 5. (continued)

	DR5-88				DR5-100			DR5-111				DR5-116
SiO_2	38.08	38.52	38.65	38.66	38.80	39.57	39.21	38.18	39.03	39.21	38.61	37.43
FeO	22.66	21.94	22.06	21.43	20.97	19.13	19.60	24.11	19.68	18.44	19.53	25.30
MnO	0.30	0.26	0.29	0.28	0.23	0.20	0.24	0.33	0.24	0.23	0.24	0.32
NiO	0.09	0.08	0.08	0.09	0.11	0.12	0.11	0.07	0.09	0.10	0.10	0.09
MgO	38.88	39.65	38.58	39.88	40.46	41.10	41.88	36.25	40.92	41.21	40.90	35.41
CaO	0.45	0.46	0.58	0.46	0.43	0.41	0.34	0.58	0.40	0.36	0.40	0.50
Total	100.45	100.91	100.23	100.81	100.99	100.53	101.37	99.51	100.36	99.54	99.78	99.05
Cations/4 oxygen												
Si	0.990	0.992	1.003	0.995	0.994	1.008	0.993	1.008	0.999	1.006	0.995	1.000
Fe^{+2}	0.493	0.473	0.478	0.461	0.449	0.407	0.415	0.532	0.421	0.395	0.421	0.565
Mn	0.006	0.006	0.006	0.006	0.005	01004	0.005	0.007	0.005	0.005	0.005	0.007
Ni	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Mg	1.506	1.523	1.492	1.529	1.544	1.560	1.582	1.427	1.562	1.576	1.571	1.411
Ca	0.012	0.013	0.016	0.013	0.012	0.011	0.009	0.016	0.011	0.010	0.011	0.014
Atomic ratios												
Mg	75.4	76.3	75.7	76.8	77.5	79.3	79.2	72.8	78.8	79.9	78.9	71.4
Fe^{+2}	24.6	23.7	24.3	23.2	22.5	20.7	20.8	27.2	21.2	20.1	21.1	28.6

Table 5. (continued)

	DR5-116	DR5-121							DR1-19			DR1-24
			edge	core								edge
SiO_2	35.36	38.39	38.05	38.52	38.95	38.69	38.82	38.25	38.89	39.68	39.16	38.28
FeO	38.55	21.12	27.69	21.10	18.13	21.62	18.09	22.85	19.73	18.48	19.30	22.18
MnO	0.56	0.23	0.32	0.25	0.21	0.26	0.22	0.26	0.27	0.23	0.18	0.30
NiO	0.08	0.09	0.09	0.08	0.12	0.11	0.12	0.08	0.11	0.12	0.10	0.07
MgO	25.05	37.99	33.71	39.39	40.68	37.42	40.93	37.26	41.93	42.26	41.77	36.79
CaO	0.64	0.41	0.41	0.41	0.41	0.44	0.41	0.46	0.35	0.39	0.39	0.54
Total	100.24	98.23	100.28	99.74	98.49	98.54	98.58	99.17	101.27	101.16	100.89	98.16
Cations/4 oxygen												
Si	1.000	1.012	1.013	1.000	1.009	1.018	1.005	1.007	0.988	1.001	0.995	1.015
Fe^{+2}	0.911	0.465	0.616	0.458	0.393	0.476	0.392	0.503	0.419	0.390	0.410	0.492
Mn	0.013	0.005	0.007	0.005	0.005	0.006	0.005	0.006	0.006	0.005	0.004	0.007
Ni	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Mg	1.055	1.492	1.337	1.524	1.571	1.467	1.580	1.462	1.588	1.590	1.582	1.454
Ca	0.019	0.012	0.012	0.011	0.011	0.012	0.011	0.013	0.009	0.011	0.011	0.015
Atomic ratios												
Mg	53.7	76.2	68.5	76.9	80.0	75.5	80.1	74.4	79.1	80.3	79.4	74.7
Fe^{+2}	46.3	23.8	31.5	23.1	20.0	24.5	19.9	25.6	20.9	19.7	20.6	25.3

Table 5. (continued)

	DR1-24			DR1-25		P5				P9		
	core					edge	core					
SiO_2	39.31	38.97	39.40	38.27	38.09	36.27	38.42	38.43	38.10	38.60	38.34	36.77
FeO	17.28	16.77	17.18	23.59	23.34	30.13	18.70	18.84	19.52	16.22	17.29	26.72
MnO	0.24	0.17	0.19	0.41	0.42	0.46	0.20	0.19	0.25	0.22	0.20	0.33
NiO	0.13	0.15	0.14	0.09	0.08	0.06	0.11	0.09	0.09	0.13	0.09	0.06
MgO	41.67	42.01	41.18	36.11	35.69	32.32	40.41	40.38	40.72	44.60	44.01	35.77
CaO	0.35	0.33	0.34	0.56	0.58	0.66	0.38	0.41	0.47	0.47	0.42	0.68
Total	98.98	98.40	98.43	99.02	98.21	99.90	98.22	98.34	99.14	100.23	100.35	100.32
Cations/4 oxygen												
Si	1.009	1.004	1.016	1.013	1.016	0.987	1.002	1.002	0.990	0.977	0.974	0.979
Fe^{+2}	0.371	0.361	0.370	0.522	0.520	0.685	0.408	0.410	0.424	0.343	0.367	0.595
Mn	0.005	0.004	0.004	0.009	0.010	0.011	0.005	0.004	0.005	0.005	0.004	0.007
Ni	0.003	0.003	0.003	0.002	0.002	0.001	0.002	0.002	0.002	0.003	0.002	0.001
Mg	1.594	1.614	1.582	1.425	1.419	1.310	1.571	1.569	1.576	1.683	1.667	1.419
Ca	0.010	0.009	0.009	0.016	0.017	0.019	0.011	0.012	0.013	0.013	0.011	0.019
Atomic ratios												
Mg	81.1	81.7	81.0	73.2	73.2	65.7	79.4	79.3	78.8	83.1	81.9	70.5
Fe^{+2}	18.9	18.3	19.0	26.8	26.8	34.3	20.6	20.7	21.2	16.9	18.1	29.5

Table 5. (continued)

	P27B				P36B edge	P36B core			P39 edge	P39 core		
SiO_2	38.92	38.86	39.55	38.54	37.01	38.28	38.15	38.82	36.90	36.93	37.05	37.68
FeO	14.80	14.50	12.77	15.87	27.06	15.74	21.91	17.24	27.98	26.15	27.21	20.94
MnO	0.21	0.22	0.16	0.21	0.38	0.19	0.28	0.25	0.41	0.39	0.39	0.30
NiO	0.11	0.14	0.16	0.14	0.06	0.13	0.08	0.12	0.05	0.06	0.05	0.07
MgO	46.03	45.97	47.64	45.39	35.72	45.28	40.44	44.64	35.72	36.11	35.95	41.05
CaO	0.40	0.45	0.33	0.36	0.67	0.38	0.50	0.41	0.72	0.74	0.70	0.51
Total	100.47	100.14	100.62	100.51	100.90	99.99	101.36	101.48	101.79	100.38	101.36	100.55
Cations/4 oxygen												
Si	0.976	0.977	0.980	0.972	0.981	0.970	0.980	0.975	0.974	0.980	0.978	0.973
Fe^{+2}	0.310	0.305	0.265	0.334	0.599	0.333	0.471	0.362	0.617	0.580	0.600	0.452
Mn	0.004	0.005	0.003	0.005	0.008	0.004	0.006	0.005	0.009	0.009	0.009	0.007
Ni	0.002	0.003	0.003	0.003	0.001	0.003	0.002	0.002	0.001	0.001	0.001	0.001
Mg	1.720	1.722	1.760	1.705	1.410	1.710	1.548	1.670	1.405	1.428	1.414	1.580
Ca	0.011	0.012	0.009	0.010	0.019	0.010	0.014	0.011	0.020	0.021	0.020	0.014
Atomic ratios												
Mg	84.7	85.0	86.9	83.6	70.2	83.7	76.7	82.2	69.5	71.1	70.2	77.8
Fe^{+2}	15.3	15.0	13.1	16.4	29.8	16.3	23.3	17.8	30.5	28.9	29.8	22.2

Table 5. (continued)

	P41				P48		P100				G14	
	edge	core					edge	core			edge	core
SiO_2	37.70	37.89	38.28	37.50	37.42	37.55	38.73	38.30	38.68	37.96	36.80	37.80
FeO	23.26	17.18	18.28	24.99	23.83	24.82	19.02	17.45	18.41	19.47	31.87	26.35
MnO	0.32	0.24	0.24	0.36	0.31	0.34	0.23	0.19	0.24	0.25	0.48	0.34
NiO	0.07	0.10	0.10	0.05	0.06	0.04	0.08	0.12	0.09	0.07	0.07	0.07
MgO	38.63	43.43	43.50	36.27	36.95	36.62	40.44	41.64	41.48	39.87	30.99	35.56
CaO	0.63	0.40	0.41	0.77	0.61	0.63	0.50	0.39	0.48	0.52	0.63	0.43
Total	100.71	99.24	100.82	99.94	99.17	100.01	99.01	98.08	99.39	98.15	100.82	100.55
Cations/4 oxygen												
Si	0.982	0.974	0.973	0.993	0.993	0.992	1.003	0.995	0.996	0.996	0.998	0.999
Fe^{+2}	0.509	0.369	0.388	0.553	0.528	0.548	0.412	0.379	0.396	0.427	0.722	0.582
Mn	0.007	0.005	0.005	0.008	0.007	0.008	0.005	0.004	0.005	0.006	0.011	0.008
Ni	0.002	0.002	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.001	0.002
Mg	1.500	1.664	1.648	1.431	1.461	1.442	1.561	1.613	1.592	1.559	1.252	1.400
Ca	0.018	0.011	0.011	0.022	0.017	0.018	0.014	0.011	0.013	0.015	0.018	0.012
Atomic ratios												
Mg	74.7	81.8	80.9	72.1	73.4	72.5	79.1	81.0	80.1	78.5	63.4	70.6
Fe^{+2}	25.3	18.2	19.1	27.9	26.6	27.5	20.9	19.0	19.9	21.5	36.6	29.4

Table 5. (continued)

	G14 edge	G14 core			G115B			G142A		G201A	
SiO_2	36.53	38.54	34.73	35.16	39.07	37.38	38.64	38.86	38.27	38.46	38.44
FeO	33.34	18.10	43.66	40.88	18.29	28.29	19.66	16.33	17.29	16.55	15.25
MnO	0.48	0.20	0.80	0.62	0.19	0.31	0.20	0.24	0.25	0.23	0.18
NiO	0.08	0.11	0.08	0.07	0.10	0.08	0.09	0.10	0.09	0.11	0.14
MgO	30.35	42.26	20.91	23.74	41.90	33.10	40.35	43.22	41.69	42.61	43.95
CaO	0.62	0.39	0.97	0.74	0.39	0.56	0.41	0.47	0.52	0.34	0.28
Total	101.41	99.60	101.13	101.21	99.93	99.72	99.35	99.22	98.10	98.30	98.24
Cations/4 oxygen											
Si	0.992	0.989	1.000	0.996	0.998	1.006	1.000	0.993	0.994	0.993	0.988
Fe^{+2}	0.757	0.388	1.051	0.968	0.391	0.636	0.426	0.349	0.375	0.357	0.328
Mn	0.011	0.004	0.019	0.015	0.004	0.007	0.004	0.005	0.006	0.005	0.004
Ni	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003
Mg	1.228	1.616	0.898	1.002	1.596	1.327	1.557	1.646	1.614	1.640	1.683
Ca	0.018	0.011	0.030	0.023	0.011	0.016	0.011	0.013	0.014	0.010	0.008
Atomic ratios											
Mg	61.9	80.6	46.1	50.9	80.3	67.6	78.5	82.5	81.1	82.1	83.7
Fe^{+2}	38.1	19.4	53.9	49.1	19.7	32.4	21.5	17.5	18.9	17.9	16.3

Table 6. Electron microprobe data for pyroxenes.
Analyses by F. Lee-Wong.

	DR5-4			DR5-34		DR5-57	DR5-83		DR5-100			
SiO_2	52.41	51.47	52.50	49.79	50.69	52.10	47.59	49.57	49.53	49.37	50.05	49.13
TiO	0.87	0.98	1.08	0.83	0.89	0.56	2.14	2.26	1.19	1.11	1.22	1.20
Al_2O_3	3.28	3.95	2.07	3.73	3.45	2.11	6.70	4.78	3.95	3.19	3.41	4.09
Cr_2O_3	0.43	0.45	0.38	0.24	0.25	0.21	0.16	0.26	0.17	0.17	0.14	0.16
FeO	6.86	6.49	7.98	8.48	9.16	8.21	7.09	8.24	9.80	11.44	10.73	10.69
MnO	0.15	0.15	0.18	0.19	0.21	0.19	0.13	0.15	0.19	0.23	0.20	0.22
MgO	17.26	16.49	16.68	13.36	13.84	14.91	12.35	12.83	13.04	12.79	13.51	12.88
CaO	19.45	20.70	20.71	20.91	21.24	21.11	22.97	23.09	20.49	19.63	21.09	19.48
Na_2O	0.37	0.36	0.29	0.35	0.39	0.37	0.47	0.43	0.40	0.47	0.38	0.47
Total	101.07	101.03	101.86	97.86	100.12	99.77	99.60	101.61	98.77	98.40	100.73	98.32
Cations/6 oxygen												
Si	1.903	1.876	1.910	1.896	1.892	1.939	1.785	1.829	1.879	1.892	1.872	1.876
Al^{iv}	0.097	0.124	0.089	0.104	0.108	0.061	0.215	0.171	0.121	0.108	0.128	0.124
Al^{vi}	0.044	0.046	0.000	0.064	0.045	0.032	0.083	0.038	0.057	0.037	0.023	0.061
Ti	0.024	0.027	0.030	0.024	0.025	0.016	0.060	0.063	0.034	0.032	0.034	0.035
Cr	0.012	0.013	0.011	0.007	0.008	0.006	0.005	0.008	0.005	0.005	0.004	0.005
Fe^{+2}	0.208	0.198	0.243	0.270	0.286	0.255	0.222	0.254	0.311	0.367	0.335	0.341
Mn	0.005	0.005	0.005	0.006	0.007	0.006	0.004	0.005	0.006	0.008	0.006	0.007
Mg	0.934	0.896	0.905	0.758	0.770	0.827	0.690	0.706	0.737	0.731	0.754	0.733
Ca	0.757	0.808	0.807	0.853	0.850	0.841	0.923	0.913	0.833	0.806	0.845	0.797
Na	0.026	0.026	0.020	0.026	0.028	0.027	0.034	0.031	0.030	0.035	0.028	0.034
Atomic ratios												
Ca	39.8	42.5	41.3	45.3	44.6	43.7	50.3	48.7	44.3	42.3	43.7	42.6
Mg	49.2	47.1	46.3	40.3	40.4	43.0	37.6	37.7	39.2	38.4	39.0	39.2
Fe^{+2}	11.0	10.4	12.4	14.3	15.0	13.3	12.1	13.6	16.5	19.3	17.3	18.2

Table 6. (continued)

	DR5-121		DR1-24			DR1-25				DR1-27		
SiO_2	50.85	50.34	50.25	51.64	52.28	46.25	47.76	49.78	47.81	50.30	49.05	51.09
TiO	0.91	0.93	0.95	1.56	1.42	2.78	1.92	1.84	1.99	0.48	2.45	1.07
Al_2O_3	2.77	2.86	2.73	1.96	2.13	6.52	4.73	4.13	5.97	3.36	4.32	4.51
Cr_2O_3	0.19	0.22	0.25	0.23	0.22	0.26	0.25	0.30	0.21	0.17	0.22	0.32
FeO	10.36	9.77	9.93	10.96	10.33	9.68	8.26	7.54	9.05	7.52	10.62	7.17
MnO	0.23	0.21	0.20	0.23	0.23	0.17	0.17	0.18	0.17	0.13	0.23	0.14
MgO	13.08	13.69	12.42	12.12	13.57	12.24	12.20	13.68	11.76	13.72	11.95	15.07
CaO	20.67	21.47	21.74	21.15	20.84	22.76	24.52	23.42	22.19	21.44	21.09	22.21
Na_2O	0.37	0.36	0.35	0.40	0.39	0.67	0.60	0.59	0.69	0.40	0.51	0.43
Total	99.43	99.86	98.82	100.26	101.42	101.33	100.42	101.47	99.84	97.52	100.46	102.01
Cations/6 oxygen												
Si	1.918	1.894	1.912	1.938	1.931	1.734	1.800	1.838	1.803	1.914	1.843	1.859
Al^{iv}	0.082	0.106	0.088	0.062	0.069	0.266	0.200	0.162	0.197	0.086	0.157	0.141
Al^{vi}	0.042	0.022	0.035	0.025	0.024	0.023	0.011	0.019	0.070	0.066	0.035	0.053
Ti	0.026	0.026	0.027	0.044	0.039	0.078	0.055	0.051	0.056	0.014	0.069	0.029
Cr	0.006	0.007	0.008	0.007	0.007	0.008	0.008	0.009	0.006	0.005	0.007	0.009
Fe^{+2}	0.327	0.307	0.316	0.344	0.319	0.303	0.260	0.233	0.285	0.239	0.334	0.218
Mn	0.007	0.007	0.006	0.007	0.007	0.005	0.006	0.006	0.005	0.004	0.007	0.004
Mg	0.735	0.767	0.705	0.678	0.747	0.684	0.686	0.753	0.661	0.778	0.669	0.817
Ca	0.836	0.865	0.886	0.851	0.825	0.914	0.990	0.926	0.897	0.874	0.849	0.866
Na	0.027	0.027	0.026	0.029	0.028	0.049	0.044	0.042	0.051	0.030	0.037	0.030
Atomic ratios												
Ca	44.0	44.6	46.5	45.4	43.6	48.1	51.1	48.5	48.6	46.2	45.8	45.5
Mg	38.7	39.6	37.0	36.2	39.5	36.0	35.4	39.4	35.9	41.1	36.1	43.0
Fe^{+2}	17.2	15.8	16.6	18.4	16.9	16.0	13.4	12.2	15.5	12.7	18.0	11.5

Table 6. (continued)

	DR1-27	P5		P27B		P36B	P39		P41			P48
SiO_2	51.11	49.52	49.39	50.05	47.97	49.14	48.70	49.09	49.10	48.74	47.63	45.59
TiO_2	1.21	1.77	2.13	0.65	1.04	1.03	0.83	1.13	2.16	1.71	2.84	3.22
Al_2O_3	4.38	3.54	4.09	5.87	5.84	3.92	4.83	3.97	4.36	5.60	4.81	6.82
Cr_2O_3	0.29	0.25	0.22	0.34	0.18	0.14	0.19	0.19	0.30	0.36	0.17	0.26
FeO	7.57	9.14	7.55	4.94	6.87	7.25	6.74	8.14	8.79	7.18	10.20	8.78
MnO	0.16	0.17	0.16	0.11	0.16	0.14	0.12	0.20	0.19	0.13	0.19	0.14
MgO	14.52	13.66	13.74	14.73	12.65	13.33	13.27	11.87	12.70	14.09	12.58	11.51
CaO	21.41	22.26	21.74	22.04	23.02	22.25	21.96	23.21	22.42	21.74	21.11	22.46
Na_2O	0.44	0.43	0.46	0.59	0.51	0.29	0.45	0.37	0.55	0.47	0.48	0.54
Total	101.09	100.75	99.47	99.33	98.22	97.49	97.09	98.18	100.57	100.02	100.01	99.32
Cations/6 oxygen												
Si	1.874	1.849	1.851	1.851	1.823	1.877	1.862	1.876	1.835	1.814	1.800	1.736
Al^{iv}	0.126	0.151	0.149	0.149	0.177	0.123	0.138	0.124	0.165	0.186	0.200	0.264
Al^{vi}	0.064	0.006	0.033	0.108	0.086	0.054	0.081	0.056	0.028	0.061	0.015	0.043
Ti	0.033	0.050	0.060	0.018	0.030	0.030	0.024	0.032	0.061	0.048	0.081	0.092
Cr	0.009	0.007	0.007	0.010	0.005	0.004	0.006	0.006	0.009	0.011	0.005	0.008
Fe^{+2}	0.232	0.285	0.236	0.153	0.218	0.232	0.215	0.260	0.275	0.223	0.322	0.279
Mn	0.005	0.005	0.005	0.004	0.005	0.004	0.004	0.006	0.006	0.004	0.006	0.005
Mg	0.794	0.760	0.767	0.812	0.716	0.759	0.756	0.676	0.708	0.781	0.709	0.653
Ca	0.841	0.891	0.873	0.873	0.937	0.910	0.900	0.950	0.898	0.867	0.855	0.916
Na	0.031	0.031	0.033	0.043	0.037	0.021	0.034	0.028	0.040	0.034	0.035	0.040
Atomic ratios												
Ca	45.1	46.0	46.5	47.5	50.1	47.9	48.1	50.4	47.8	46.3	45.3	49.6
Mg	42.5	39.3	40.9	44.2	38.3	39.9	40.4	35.8	37.6	41.8	37.6	35.3
Fe^{+2}	12.4	14.7	12.6	8.3	11.7	12.2	11.5	13.8	14.6	11.9	17.1	15.1

Table 6. (continued)

		G14		G115B				G201A	
SiO_2	44.78	50.46	51.15	50.59	52.08	50.48	49.91	50.27	50.54
TiO	3.40	1.01	1.00	0.73	0.60	0.88	0.93	1.02	0.82
Al_2O_3	7.32	2.61	2.72	2.60	2.04	2.79	1.89	2.44	2.77
Cr_2O_3	0.22	0.23	0.31	0.17	0.21	0.19	0.15	0.26	0.16
FeO	9.89	8.40	8.49	9.86	9.11	10.19	15.69	12.92	10.68
MnO	0.15	0.16	0.15	0.21	0.18	0.21	0.32	0.25	0.21
MgO	11.50	13.57	12.92	14.93	15.76	14.10	10.96	11.15	13.33
CaO	21.97	22.18	22.13	19.51	18.96	19.81	18.97	20.35	20.41
Na_2O	0.53	0.44	0.43	0.28	0.24	0.34	0.36	0.41	0.36
Total	99.75	99.05	99.31	98.87	99.18	98.99	99.20	99.06	99.28
Cations/6 oxygen									
Si	1.706	1.905	1.923	1.910	1.944	1.909	1.930	1.927	1.912
Al^{iv}	0.294	0.095	0.077	0.090	0.056	0.091	0.070	0.073	0.088
Al^{vi}	0.036	0.022	0.044	0.026	0.034	0.034	0.017	0.038	0.036
Ti	0.097	0.029	0.028	0.021	0.017	0.025	0.027	0.029	0.023
Cr	0.007	0.007	0.009	0.005	0.006	0.006	0.005	0.008	0.005
Fe^{+2}	0.315	0.265	0.267	0.311	0.284	0.322	0.507	0.414	0.338
Mn	0.005	0.005	0.005	0.007	0.006	0.007	0.011	0.008	0.007
Mg	0.653	0.764	0.724	0.840	0.877	0.795	0.632	0.637	0.752
Ca	0.897	0.897	0.891	0.789	0.758	0.802	0.786	0.836	0.827
Na	0.039	0.032	0.032	1.021	0.017	0.025	0.027	0.030	0.026
Atomic ratios									
Ca	48.1	46.6	47.4	40.7	39.5	41.8	40.8	44.3	43.2
Mg	35.0	39.6	38.5	43.3	45.7	41.4	32.8	33.8	39.2
Fe^{+2}	16.9	13.8	14.2	16.0	14.8	16.8	26.4	21.9	17.6

Table 7. Electron microprobe data for opaque minerals. Fe^{+2} and Fe^{+3} in magnetite were recalculated with an ulvospinal molecule (Carmichael, 1967). Analyses by F. Lee-Wong.

	DR5-34 Ti mgnt	DR5-34 Ti mgnt	DR1-25 Ti mgnt	P5 Ti mgnt	P27B Ti mgnt	P39 Ti mgnt	P39 Ti mgnt	P41 Ti mgnt	P48 Ti mgnt	G142A Ti mgnt
SiO_2	0.87	2.34	0.58	0.87	0.62	0.69	0.65	0.71	0.68	1.45
TiO_2	25.03	25.79	21.35	30.71	27.94	29.65	29.37	26.55	27.38	17.75
Al_2O_3	1.25	1.31	5.30	1.36	2.98	3.14	3.24	2.88	3.53	6.31
Cr_2O_3	3.76	1.83	1.75	1.67	1.78	1.84	1.67	1.58	1.67	1.49
Fe_2O_3	14.64	11.82	18.52	4.95	8.30	5.53	5.64	10.81	7.77	22.78
FeO	56.24	59.14	52.73	61.15	58.41	60.47	60.09	57.02	57.67	50.77
Total	101.80	102.24	100.23	100.71	100.03	101.32	100.66	99.55	98.69	100.54
Cations/32 oxygen										
Si	0.245	0.922	0.175	0.247	0.176	0.193	0.192	0.213	0.196	0.211
Ti	5.491	5.604	4.674	6.781	6.181	6.451	6.442	5.906	6.112	3.903
Al	0.421	0.451	1.821	0.459	1.024	1.078	1.120	0.996	1.247	2.180
Cr	0.877	0.417	0.420	0.389	0.424	0.417	0.385	0.356	0.392	0.351
Fe^{+3}	3.228	2.568	4.061	1.095	1.837	1.217	1.225	2.419	1.747	5.028
Fe^{+2}	13.737	14.279	12.849	15.029	14.358	14.642	14.634	14.107	14.309	12.429

Table 7. (continued)

	DR5-4 ilmenite	DR5-34 ilmenite	DR5-57 ilmenite	P5 ilmenite	G115B ilmenite
SiO_2	1.40	0.70	0.48	0.59	0.81
TiO_2	50.78	50.58	52.59	52.34	49.90
Al_2O_3	0.09	0.05	0.08	0.01	0.03
Cr_2O_3	1.64	1.56	1.33	1.77	1.67
FeO	47.34	47.71	45.43	46.08	48.35
Total	101.25	100.60	99.92	100.80	100.76
Cations/6 oxygen					
Si	0.070	0.035	0.024	0.030	0.041
Ti	1.896	1.913	1.981	1.959	1.890
Al	0.005	0.003	0.005	0.000	0.002
Cr	0.065	0.063	0.053	0.070	0.067
Fe^{+2}	1.965	2.006	1.903	1.917	2.036

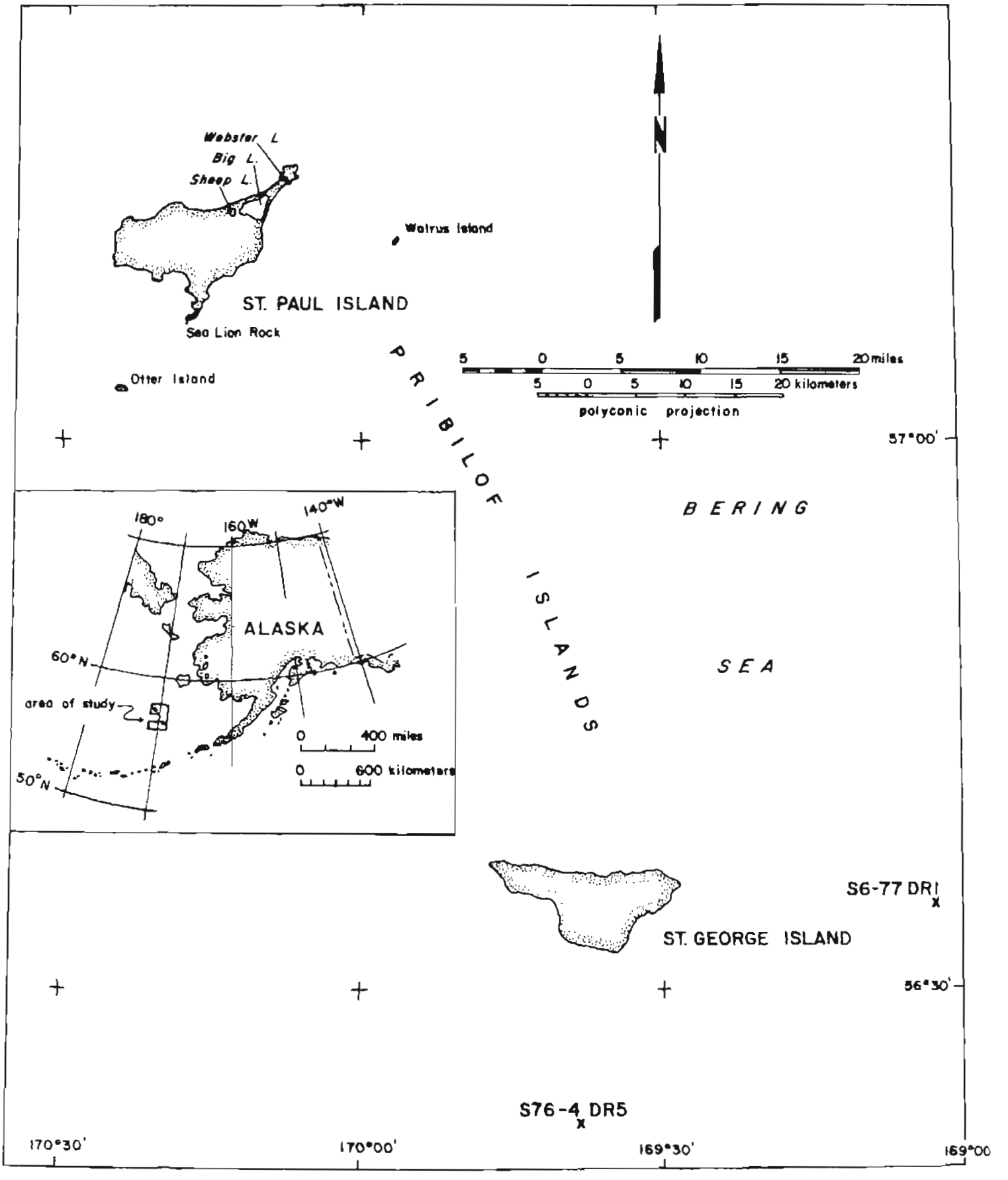


Figure 1. Location map of the Pribilof Islands and U. S. Geological Survey dredge sites S76-4 and S6-77.

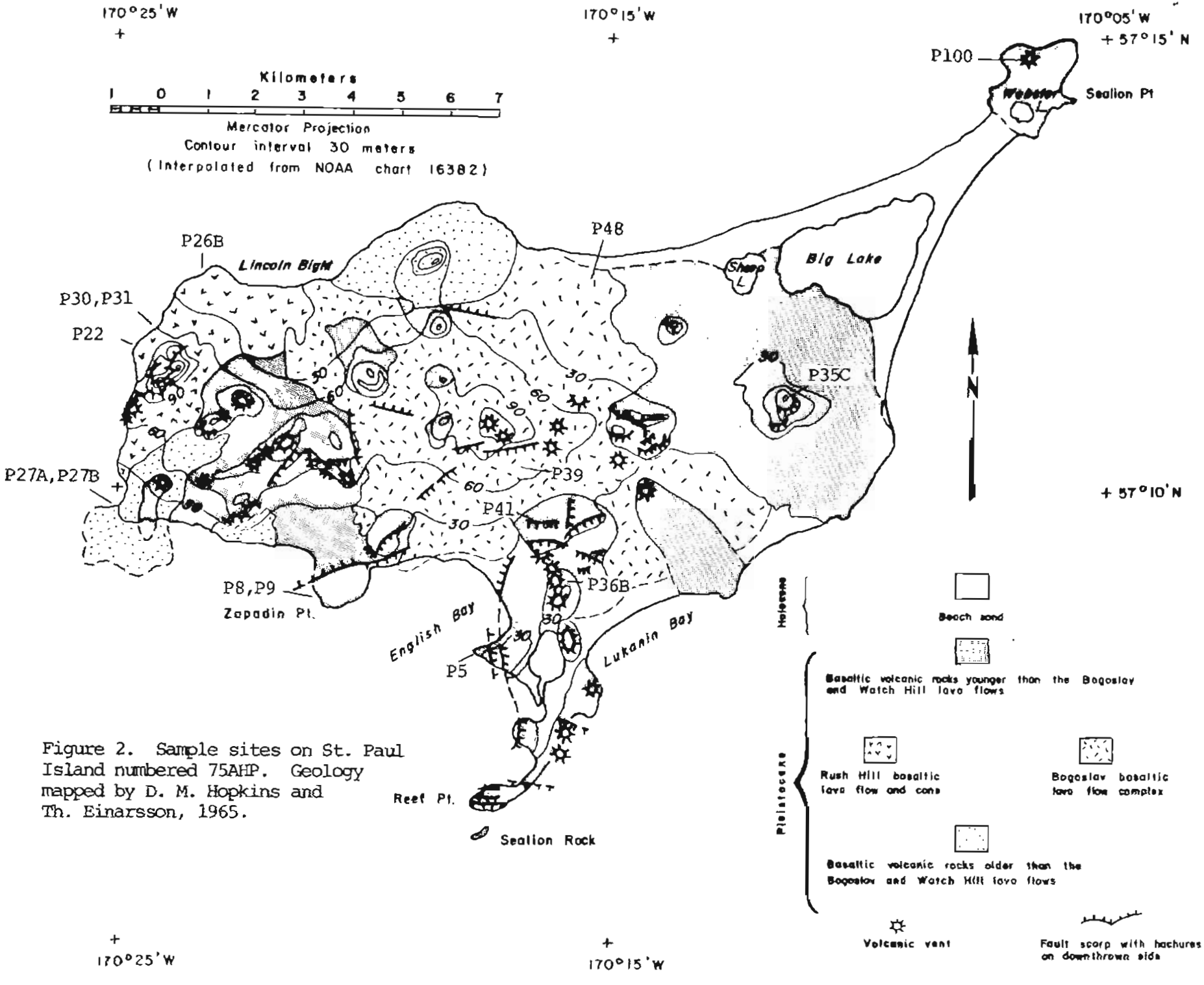
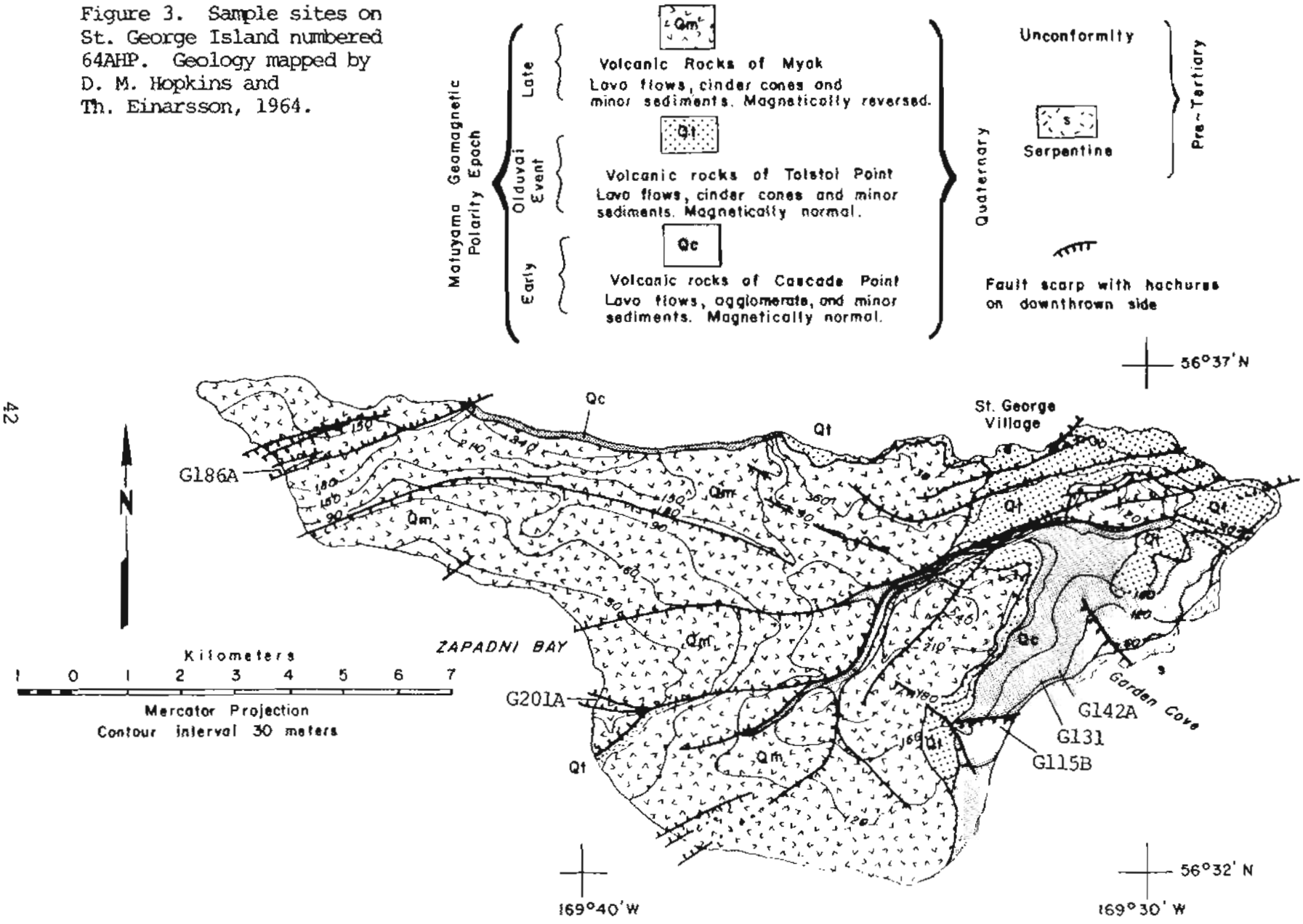


Figure 2. Sample sites on St. Paul Island numbered 75AHP. Geology mapped by D. M. Hopkins and Th. Einarsson, 1965.

Figure 3. Sample sites on St. George Island numbered 64AHP. Geology mapped by D. M. Hopkins and Th. Einarsson, 1964.



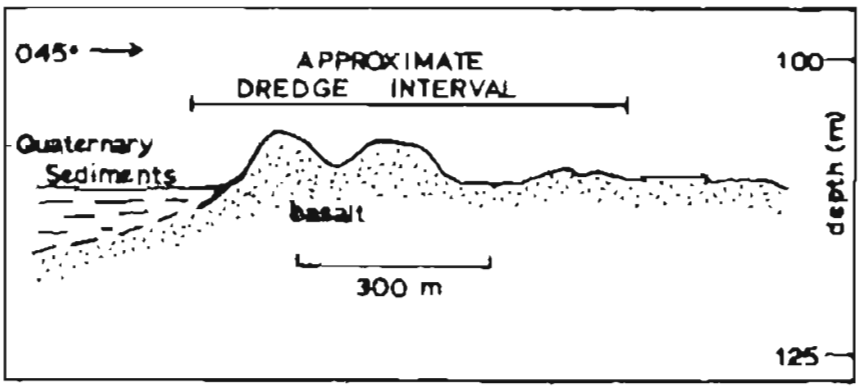


Figure 4. Dredge site S76-4 DR5.

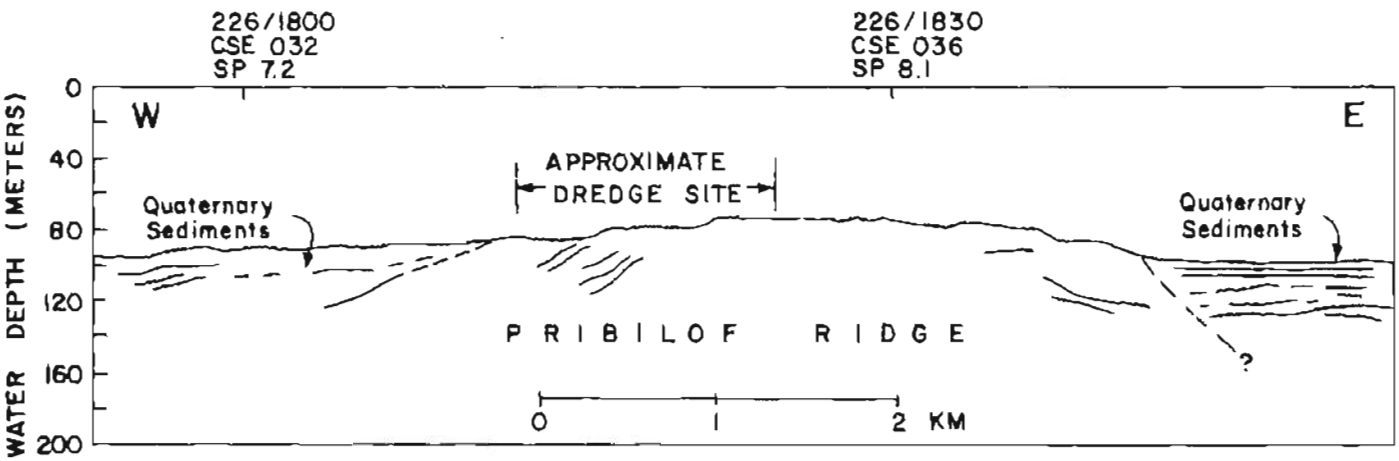


Figure 5. Dredge site S77-6 DR1.

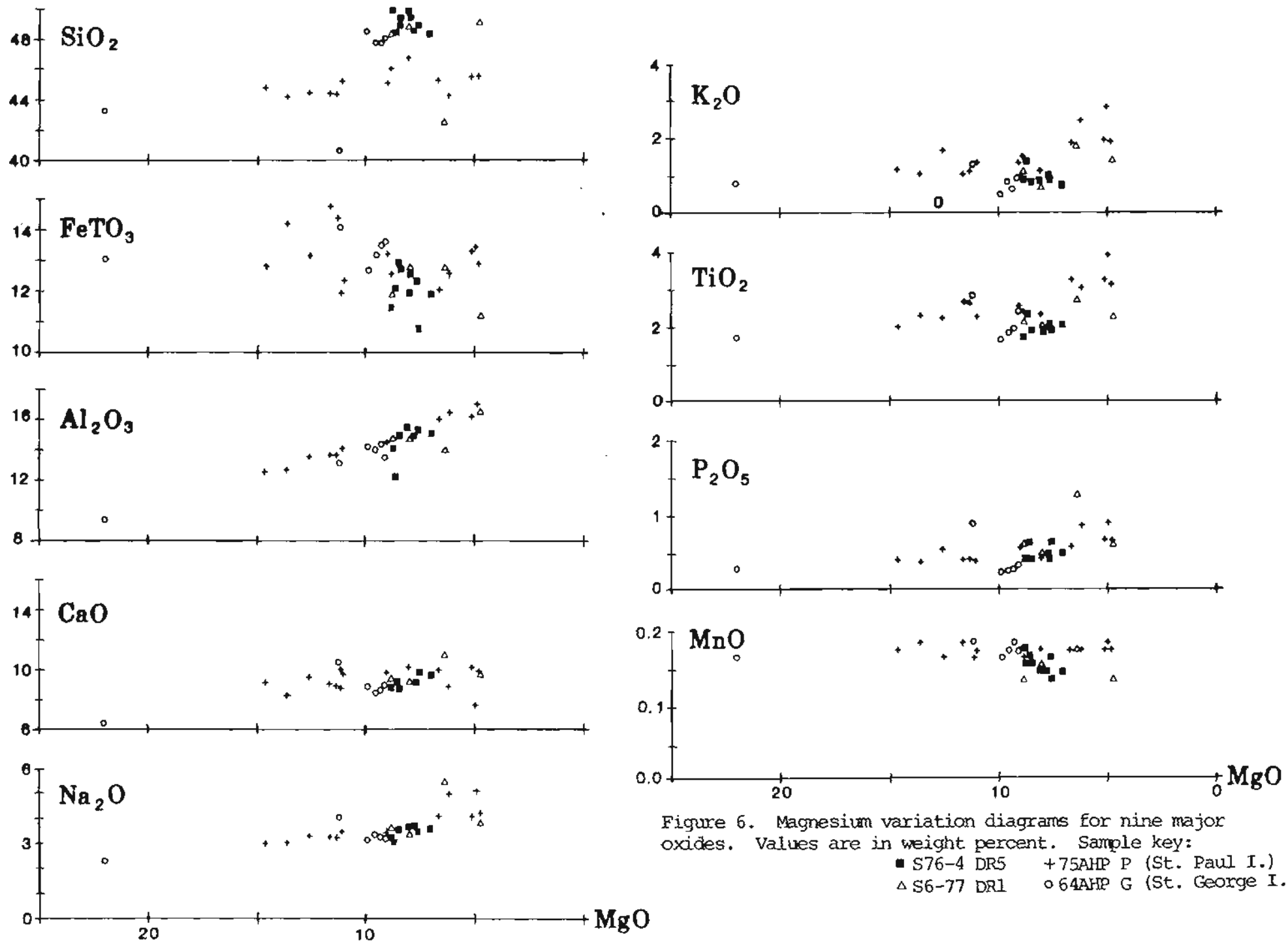


Figure 6. Magnesium variation diagrams for nine major oxides. Values are in weight percent. Sample key:

■ S76-4 DR5 + 75AHP P (St. Paul I.)
△ S6-77 DR1 ○ 64AHP G (St. George I.)

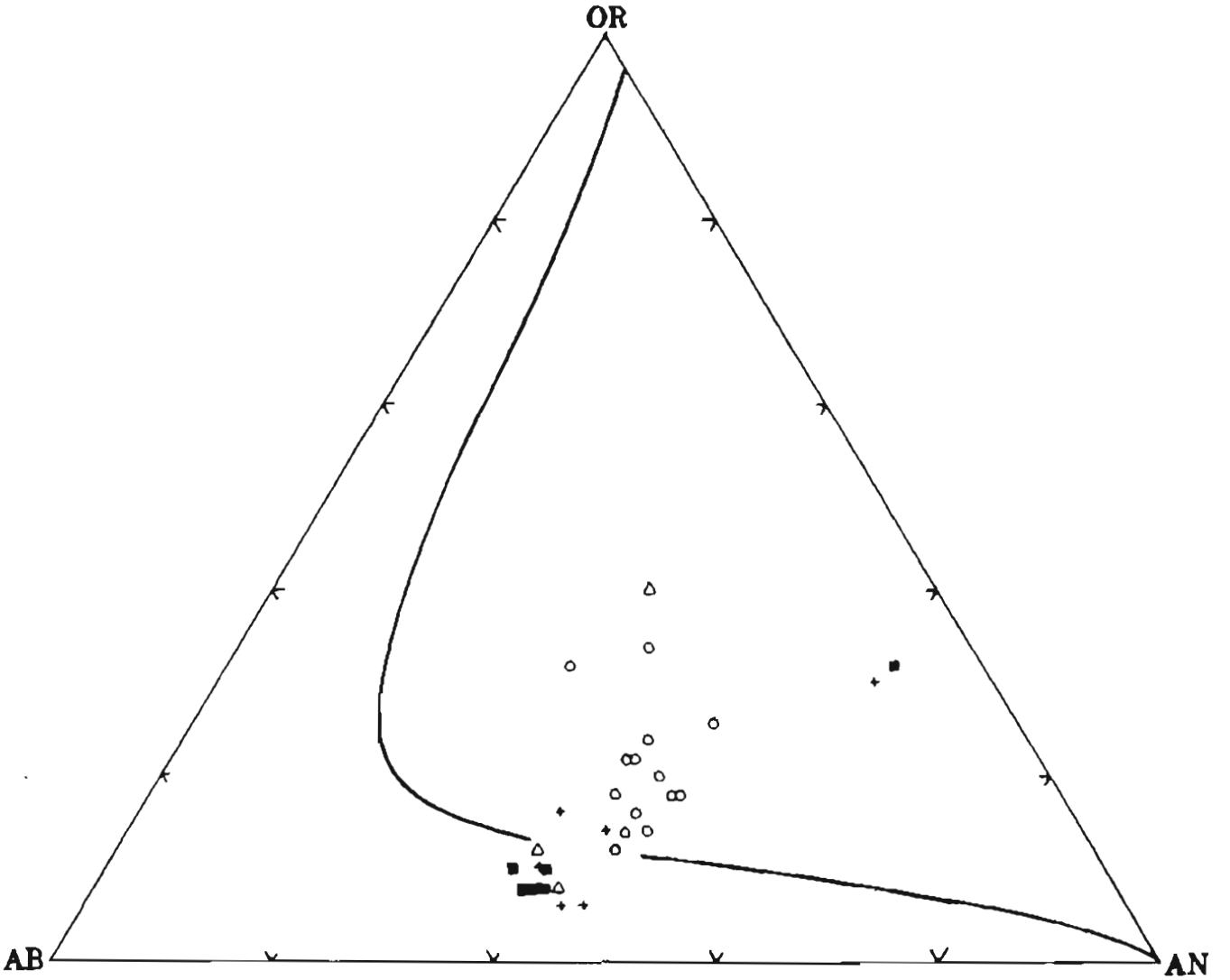


Figure 7. Ternary plot of molecular proportions of normative feldspars. Symbols defined in Figure 6.

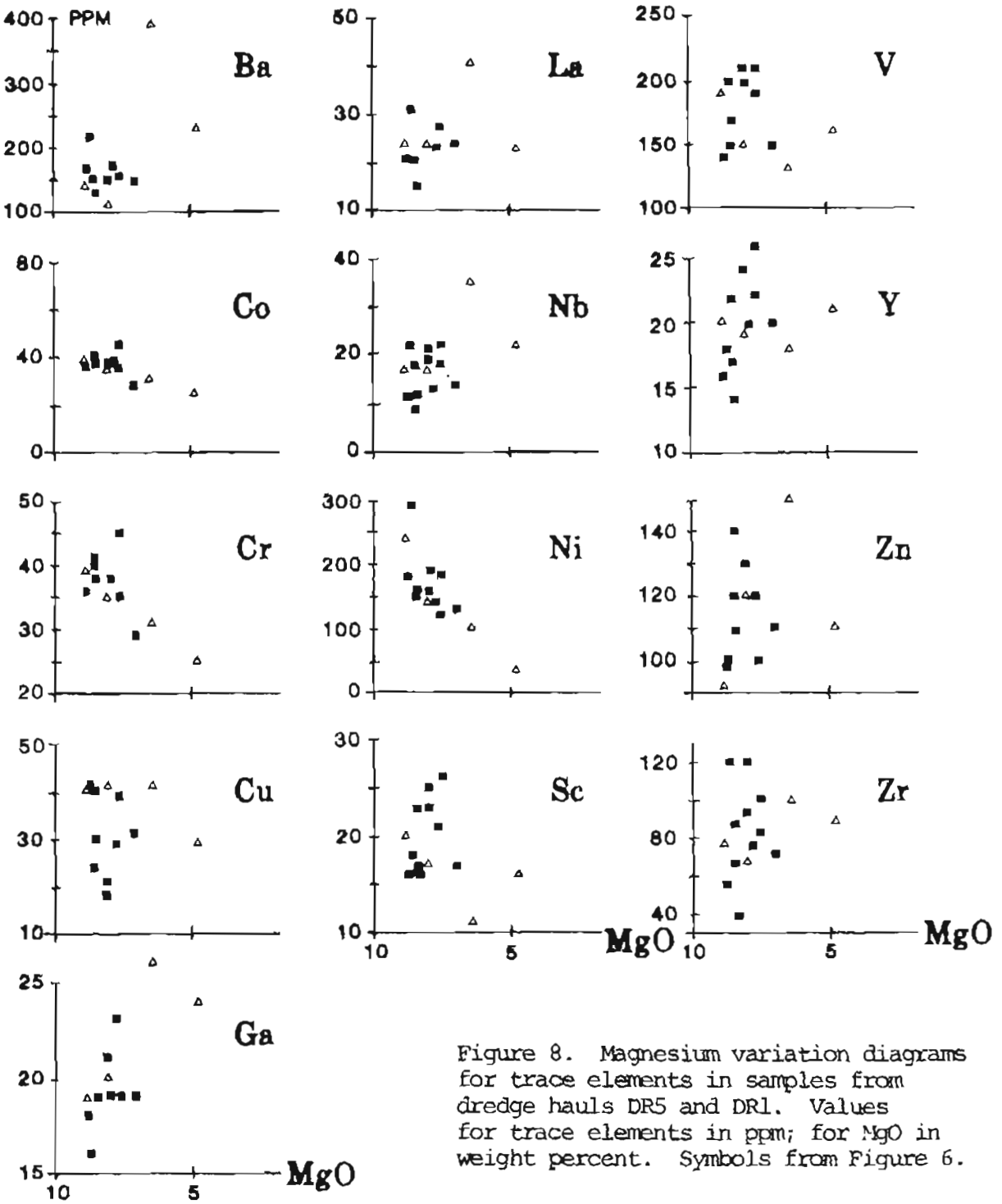


Figure 8. Magnesium variation diagrams for trace elements in samples from dredge hauls DR5 and DR1. Values for trace elements in ppm; for MgO in weight percent. Symbols from Figure 6.

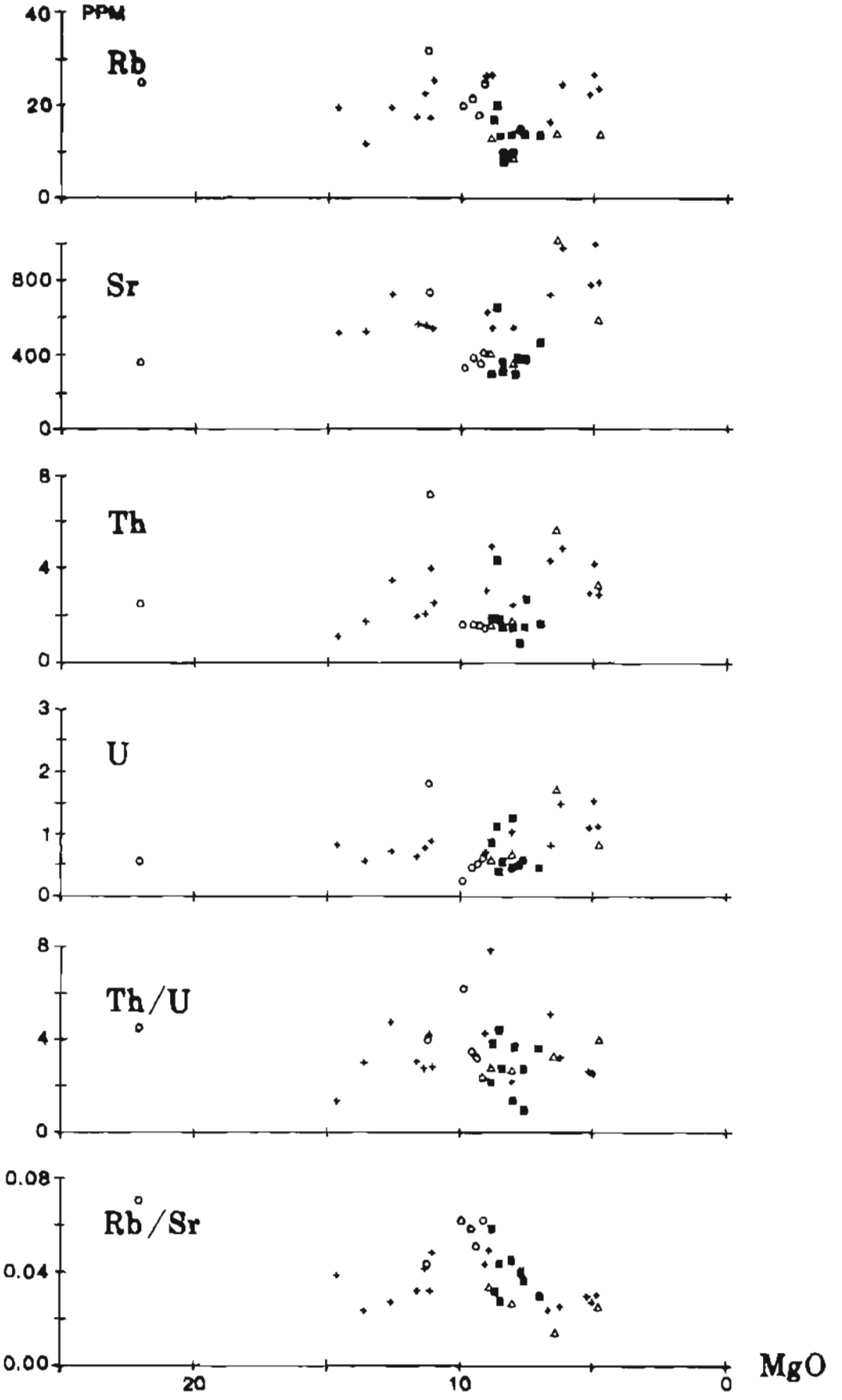


Figure 9. Magnesium variation diagrams for Rb, Sr, Th, U, Th/U and Rb/Sr. Units for trace elements are ppm; for Mgo, weight percent. Symbols from Figure 6.

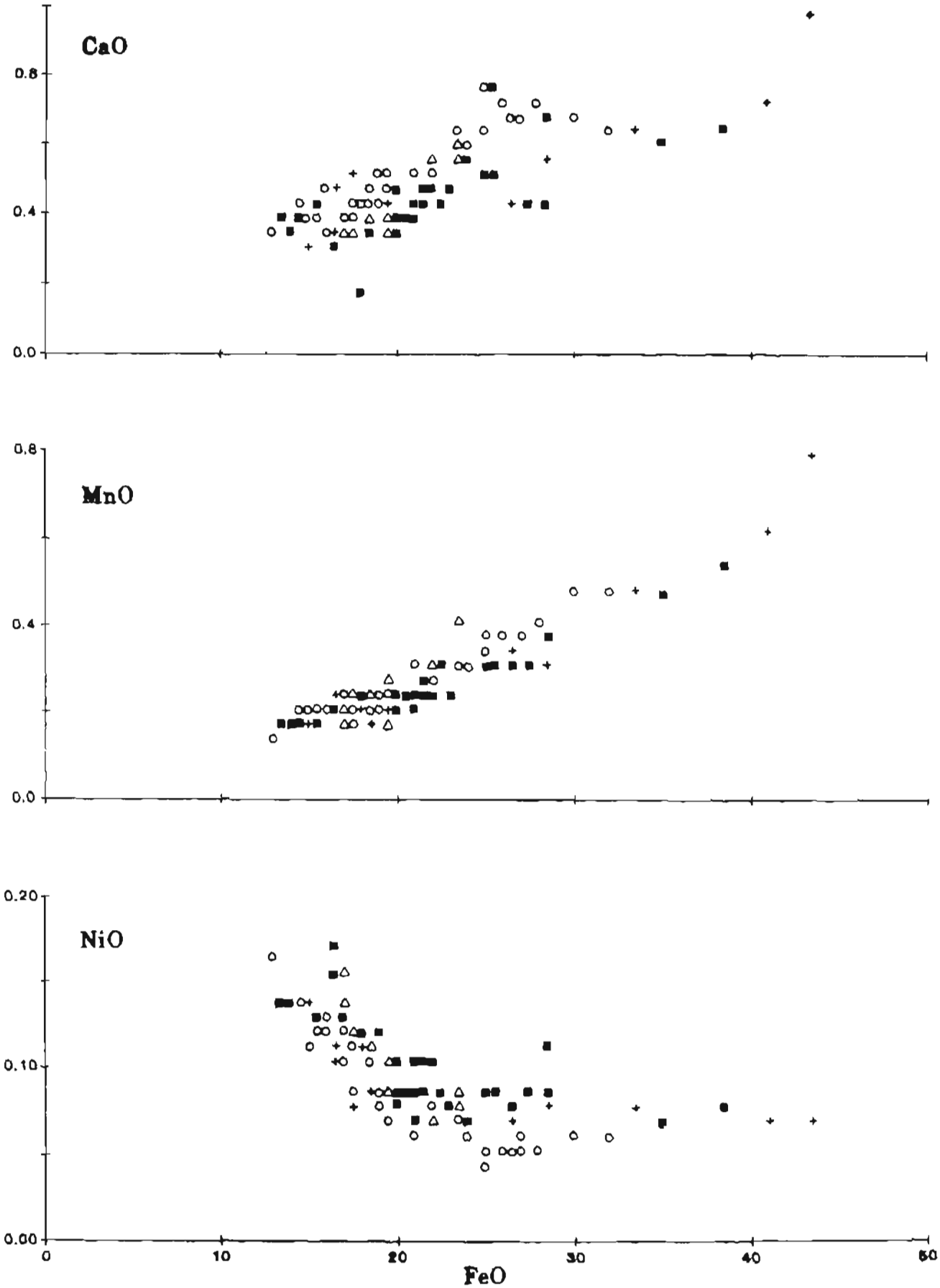


Figure 10. FeO variation diagrams for electron microprobe analyses of olivine. Values given in weight percent. Symbols from Figure 6.

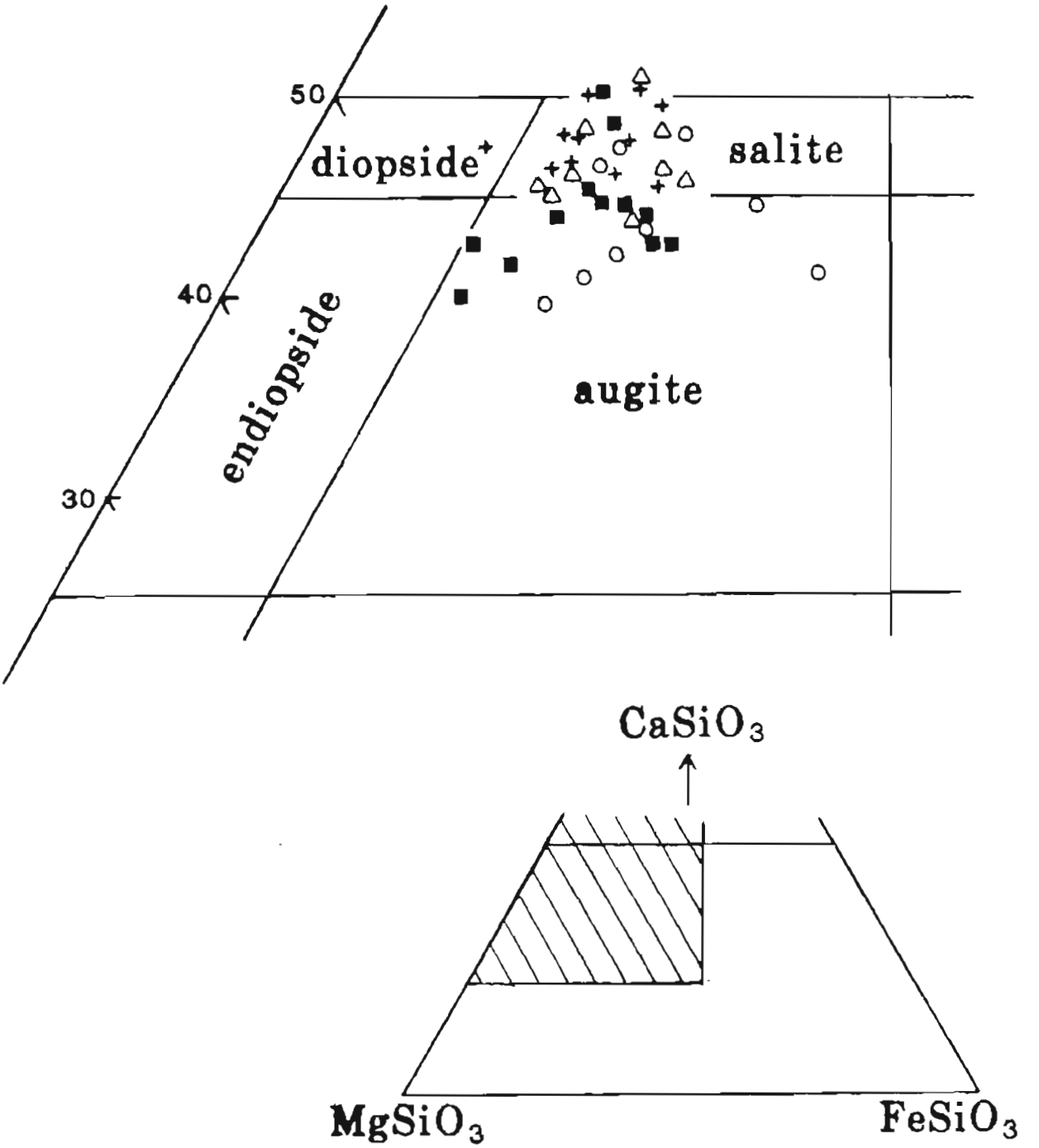


Figure 11. Ternary diagram of electron microprobe analyses of pyroxene normalized from molecular proportions. Fields defined by Poldervaart and Hess (1951). Symbols from Figure 6.

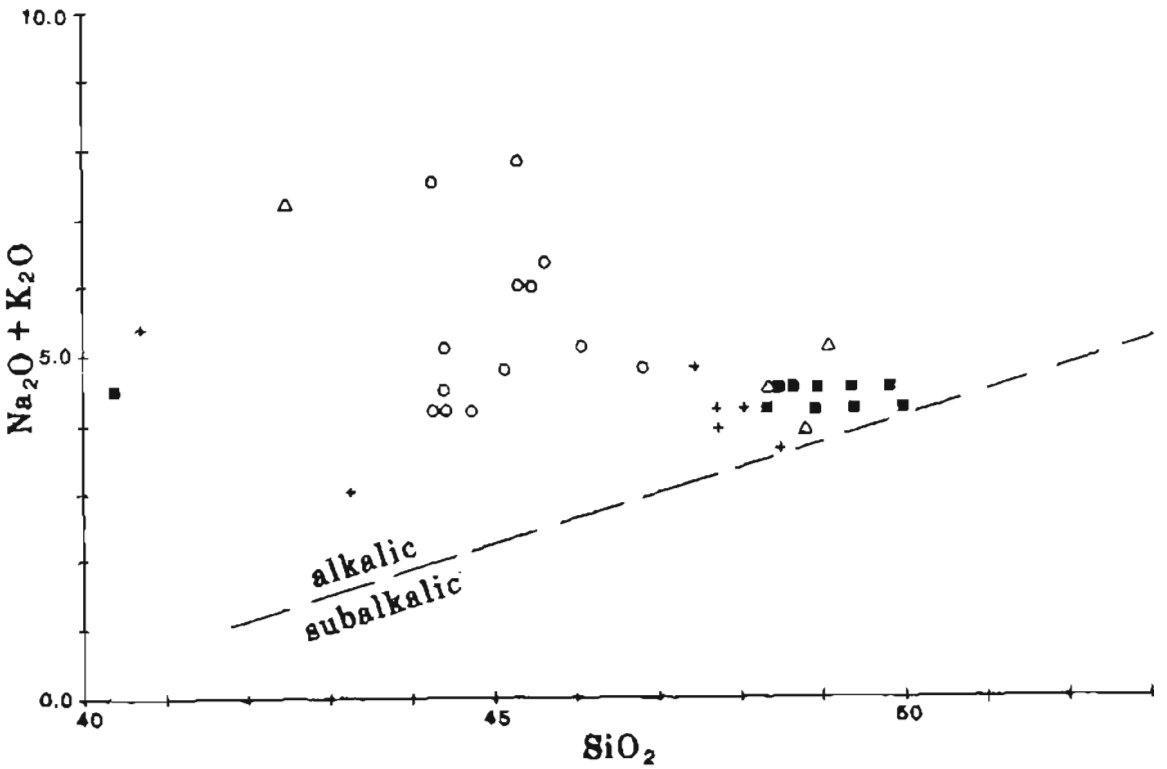


Figure 12. Alkali-silica plot of data from the Pribilof Islands and dredge hauls. Values are given in weight percent. Fields defined by MacDonald and Katsura (1964). Symbols from Figure 6.

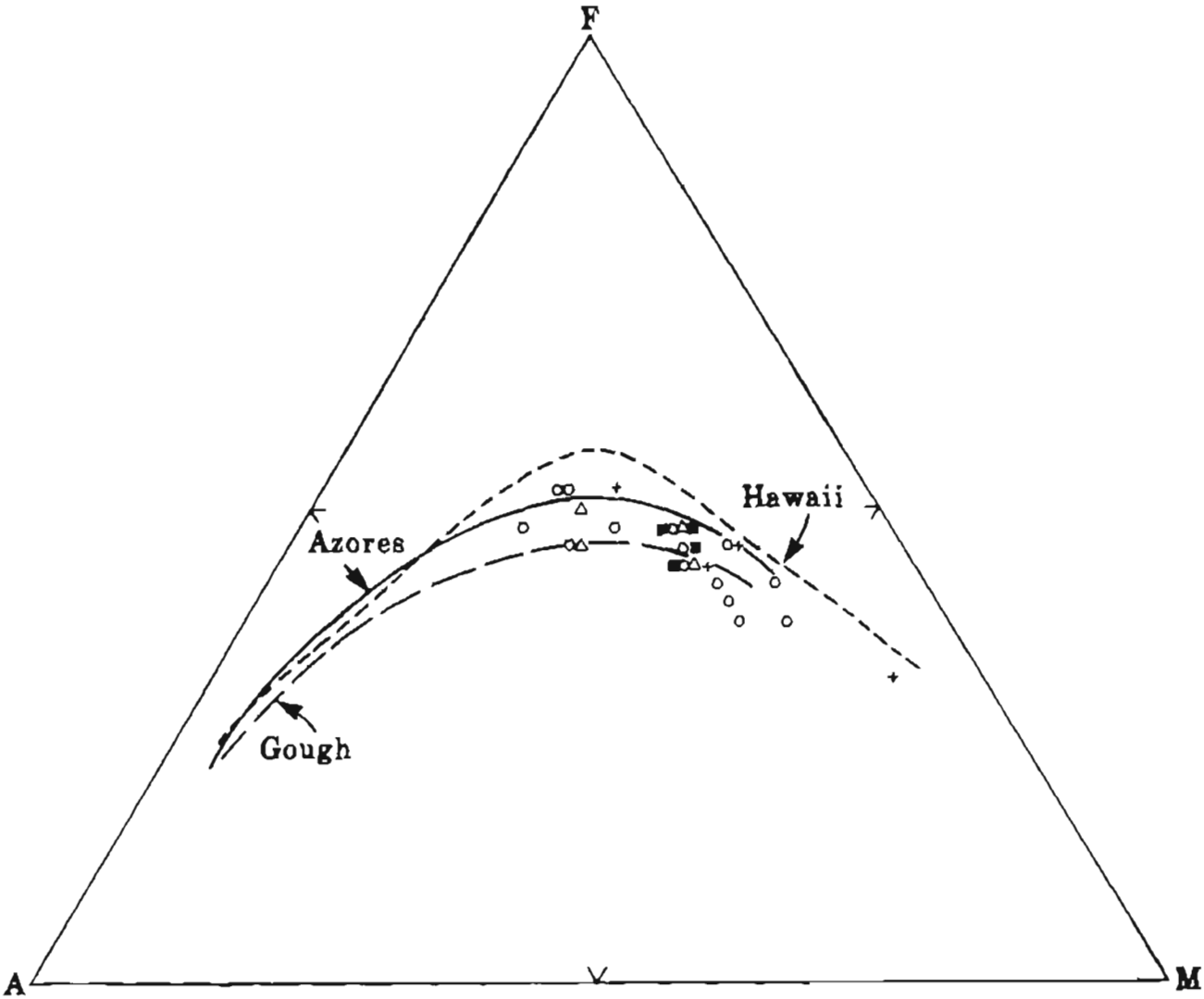


Figure 13. Ternary plot of F (total iron as FeO), A (alkalis K_2O + Na_2O), and M (MgO) normalized from weight percent data. Trends of other alkalic oceanic island groups are also included. Azores and Gough Island data from LeMaitre (1962); Hawaiian Islands data from MacDonald and Katsura (1964). Symbols from Figure 6.