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Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

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Introduction

The data reported here form the basis of an on-going study of the geochemistry of Missi Group volcanic rocks in the Wekusko Lake area, Manitoba. Results of the project will:

1. provide a geochemical reference section characterizing the youngest recognized supracrustal rocks in the Flin Flon belt. This will aid the recognition of similar rocks in adjacent high grade terrains where metamorphism and deformation have obscured stratigraphic relationships.

2. provide evidence on the nature of igneous processes in an Early Proterozoic volcanic arc.

The Wekusko Lake area lies near the east end of the Early Proterozoic Flin Flon - Snow Lake volcanic belt. The area has been mapped by Stockwell (1936), Armstrong (1941), and Frarey (1950). Shanks and Bailes (1977), Gordon (1981), Cerny et al (1981), Gordon and Gall (1982), Bailes (1985), and Galley et al (1985, 1986) have reported on various aspects of the local geology.

Missi Group volcanic rocks include basalt, andesite, dacite, and rhyolite flows and breccias as well as volcaniclastic layers. They are intruded by quartz-feldspar porphyry and quartz-eye granite. The extrusive rocks stratigraphically overly cross bedded sandstone and polymictic conglomerate in a northeast trending synform immediately east of Herb Lake townsite. All rocks in the area have experienced two major episodes of deformation and have been metamorphosed at greenschist facies or higher grade. Based on the absence of pillow structures, and the appearance of flattened shards in felsic volcanic rocks, Shanks and Bailes (op. cit.) and Gordon and Gall (op. cit.) suggest that the Missi Group volcanic rocks were deposited subaerially. Gordon et al (in press) report an 1832+/- 2 Ma. U-Pb zircon age for a Missi Group rhyolite.

Sampling Method

Samples were collected using an unbalanced hierarchical sampling design (e.g. Garrett, 1983). The highest level in the design was defined by seven volcanic units plus two intrusive units (quartz- feldspar porphyry and quartz-eye granite) as shown on Figure 1. Within each of the nine units, one to eleven sample sites were selected. Poor exposure and glaciated outcrops restrict the number of sites at which samples can be readily obtained by sledge hammer, hence random selection techniques (Cameron et al, 1979) were not used. At each site, one to five outcrop samples were collected within a ten metre interval across strike. Each sample consisted of a single three to five kilogram piece of unweathered rock.

Samples were trimmed with a diamond saw to remove any vestigial weathered material, and chips were saved for thin section preparation. The remaining material was crushed, approximately 100 grams were split and ground to -250 mesh and the resulting powder submitted for analysis. Duplicates of several powders were analyzed along with the original material.

Petrography

Representative samples from each unit were chosen for thin section examination. Mineralogy and estimated modes are given in Table 1. The original textures and mineralogy have generally been destroyed by metamorphism, but in a few samples, feldspar and/or quartz phenocrysts are recognizable.

Analytical chemistry

Analyses reported in Table 2 were obtained in the laboratories of the Geological Survey of Canada. The elements Si, Ti, Al, Fe, Mn, Ca, Na, K, and P were measured by wavelength dispersion X-ray fluorescence, following fusion in a lithium tetraborate-lithium fluoride flux. $CO_2(T)$, $H_2O(T)$, and S were determined by infrared absorption of gases evolved on ignition. FeO was determined by the Wilson method. Nb, Rb, Sr, Y, and Zr were determined by energy dispersion X-ray fluorescence, while Co, Cr, Ni, and V were measured by optical spectrometry. Table 3 shows laboratory estimates of accuracy.

Rare earth and trace element data presented in Table 5 were obtained from Nuclear Activation Services Limited of Hamilton, Ontario. The company's quoted detection limits are given in Table 4.

Preliminary results

Classification

Major element compositions straddle the tholeiitic - calc-alkaline boundary in the usual classification schemes. On an AFM plot (Figure 2), most unit C site averages fall in the calc-alkaline field of Irvine and Baragar (1971); while most unit F site averages and all unit H site averages plot in the tholeiitic field. Using Miyashiro's (1974) criteria, most of these averages are classified as tholeiitic.

Trace element analyses of the mafic units fall in the calc-alkaline basalt fields of Pearce and Cann (1973) (Figure 3), and the destructive plate margin field of Wood (1980) (Figure 4).

Comparison with Amisk Group rocks

Parslow and Gaskarth (1984, 1986) report means and standard deviations of analyses of some Amisk Group volcanic rocks, classified by silica content. The Missi Group analyses reported here were similarly subdivided and the resulting means tested for equality with the Amisk Group values. The means of Missi Group "basalts", "basaltic andesites", and "andesites" (weight percent silica < 53, 53 - 55.9, and 55.9 - 61.9, respectively) are significantly higher in Al_2O_3, Fe_2O_3, K_2O, P_2O_5, Rb, Y, and Zr; and significantly lower in FeO, MgO, Ni, and V. In rocks with greater than 61.9 % silica only the relationships for MgO, Rb, and Zr are significant.

These results contrast with those of Bailes (op. cit.), who found Missi Group basalts in the Saw Lake area to be TiO_2 and Ni rich with respect to analyses of "typical" Amisk Group basalts. It is apparent that geochemical characterization of individual stratigraphically defined volcanic units will be extremely useful for correlation, but that the "Amisk" and "Missi" divisions are too broad to be chemically distinct.

Petrogenetic processes

Site averages of oxides and trace elements in units C, F, and H vary systematically with stratigraphic position. Within unit C, the concentrations of TiO_2, K_2O, P_2O_5, total Fe, Rb, Nb, Y, and Zr increase stratigraphically upwards, while the concentrations of MgO, CaO, and Ni decrease. Compositions in Unit H have the opposite trends. Unit F displays less regular behaviour, but does show an upwards decrease in MgO, CaO, and Y. Figure 5 illustrates a typical geochemical section. The regularity of these trends suggests that consecutive eruptions sampled a magma or magmas having compositions controlled by simple igneous processes.

Log-log diagrams of trace elements having very different geochemical behaviour may be used to discriminate between magmatic suites that have evolved by fractional crystallization, partial fusion, or mixing processes (e.g. Cocherie, 1986; Gill, 1981). Regression lines fitted to unit C analyses for such elements are significant and have steep slopes, consistent with magma evolution controlled by fractional crystallization. Data from the other mafic units (F and H) are scattered and have shallower slopes, probably reflecting magma mixing or contamination. Figure 6 illustrates this behaviour.

Rare earth element patterns of most units (Figure 7) have negative Eu anomalies, suggesting that source melts were in equilibrium with plagioclase. The moderate to large REE total contents and LREE/HREE ratios are consistent with fractionation of amphibole or pyroxene.

Site averages of major element concentrations of units C, F, and H have regular trends when plotted on the olivine and diopside projections of Cawthorn and O'Hara (1976) (Figures 8 and 9), but these do not correspond to simple fractionation models. When the data are treated by the method of Grove and Baker (1984) (Figures 10 and 11) there is a similar lack of correspondence with simple fractionation trends. Missi Group volcanic rocks have relatively high magnetite contents, a phase not considered in deriving the pseudo-ternary diagrams. This may provide a partial explanation for the lack of correspondence of rock analyses with experimentally determined cotectics and reaction curves.

A model involving both crystal fractionation and mixing/assimilation will be required to account for all of the compositional variations observed in Missi Group volcanic rocks.

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Figure captions

Figure 1: Sample locations. Geology from Stockwell (1936).

Figure 2: AFM plot of site average compositions. Calc-alkaline - tholeiitic boundary from Irvine and Baragar (1971).

Figure 3: Ti-Zr-Y plot of site average compositions. Field boundaries from Pearce and Cann (1973). A: low K tholeiites; B: ocean floor basalts, low K tholeiites, and calc-alkali basalts; C: calc-alkali basalts; D: within plate basalts.

Figure 4: Th-Hf-Ta plot of site average compositions. Field boundaries from Wood (1980). A: N type MORB; B: E type MORB and tholeiitic within-plate basalts; C: Alkaline within-plate basalts; D: Destructive plate margin basalts and differentiates.

Figure 5: Variation of site average Y with stratigraphic position. Composite section derived from field observations and map of Stockwell (1936).

Figure 6: Site average $\log_{10}$ ppm Cr vs $\log_{10}$ ppm Rb.

Figure 7: Chondrite normalized rare earth element patterns of typical samples.

Figure 8: Site average weight percentage projection from olivine, vapor, and Na_2O. Projection and field boundaries from Cawthorn and O'Hara (1976).

Figure 9: Site average weight percentage projection from diopside, vapor, and Na_2O. Projection and field boundaries from Cawthorn and O'Hara (1976).

Figure 10: Site average oxygen units projection from plagioclase. Projection and field boundaries from Grove and Baker (1984).

Figure 11: Site average oxygen units projection from clinopyroxene. Projection and field boundaries from Grove and Baker (1984).

Table 1: Petrography of selected samples

site	Irvine-Baragar classification	ts #	textures	Qtz	Pl	Kfs	Qfm	Bt	Ms	Chl	Hbl	Cum	Cal	Ep	Opq	Ap	Zrn	Spn	others
A1	ca rh p	1	Pl-p f		8		76	7	4	t			5						
A2	ca an ha p	1	Pl-p		5		50	22	t				6	9	3	t			
A3	ca rh p	1	Pl-p		5		57	14	3	2			12	2	5	t	t		
B1	ca rh p		Qtz,Pl-p f		5		68	5	15				4		2				1 Tur
B2	ca rh a		Qtz,Pl-p	2	8		46	1	37				5		2				1 Tur
B3	ca rh p		Pl-p f		1		47	20	22				10		t				t Tur
C1	ca ba ha a	1			5		20	5			65		3		2				
C2	ca an ha a	1			7		50	3		t	33		t	3	3	t			
C3	ca ba ha r	1	Qtz-1	3	3		47	7		1	34			3	1	1			
C4	ca an ha a	2	Pl-p		1		39	30	4	t			8	10	7	1			t Tur
C5	ca an ha a	1	Pl-p f		2		50	13	10				10	10	5	t			
C6	th da a	2	f		8		67	12	3	1			4		5				
C7	ca rh a	2	f		1		63	20	5				2		7	2			
C8	th da a	1	Qtz-a	12	1		46	30	1				1		8	t			
C9	th rh a	2	Pl-p		1		65	10	7	t			7		10	t		t	
D1	th rh p	1	f				68	18	7				5		2		t		t Tur
E1	th rh a	2	Pl-p f		2		40	3	42				3		9	t	t		t Tur
E2	th rh p	1	Pl-p		6		64	t	20				7		3	t			t Tur
E3	th rh p	1	Qtz,Ks-p f	1	10	2	65	3	12				2		5	t	t		
F1	ca ba ha r	1					18	5			72				5				
F2	ca ba ha r	1	Qtz-1 Pl-p			15	18	5			46			13	3	t			
F3	th an a	1	Cal-1				32	30	t	1	20		5	12					t Tur
F4	th ba a	1					37	12			40			1	10	t			
F5	ca ba ha a	1					26	12		10	40			2	10				
F6	ca ba ha a	1	Qtz-1	3			29	2		7	40		1	10	8				
F7	th an a	1					53	2	8	1			23	10	3				
F8	ca ba a	1					40	1			52		1	3	3				
F9	ca ba ha a	1	Qtz-1	1			45	26		2	10		2	4	10				
F10	ca an ha a	1					58	18		2	8			10	4	t			
F11	th an a	1	Qtz,Pl-1	2	2		46	15		5	12		5	3	10	t			

Table 1 (cont'd): Petrography of selected samples

site	Irvine-Baragar classification		ts #	textures	Qtz	Pl	Kfs	Qfm	Bt	Ms	Chl	Hbl	Cum	Cal	Ep	Opq	Ap	Zrn	Spn	others
G1	th an	r	1	Pl-p f		1		70		25				1		3	t			t Tur
G2	ca rh	a																		
G3	ca rh	a																		
G4	ca rh	a	1	Qtz-v f	5		t	85		7				2		1		t		t Tur
G5	ca rh	a																		
G6	ca rh	p	1	Qtz-v Fs-p f	12	5	1	75		3				2		2				
G7	ca rh	a																		
G8	ca rh	p	1	Fs-p		2	2	60	1	27				5		3				
G9	ca rh	a																		
G10	ca rh	a	7	Qtz-v Fs-p	5	2	1	69	3	9				5	1	5		t		
H1	th an	a	1	Qtz-v	3			39	32		t	15		3	1	6	t	t		
H2	th ba	r	1	Qtz-l,v	13			30	10		1	40		1	2	3	t			t Tur
H3	th ba	r																		
H4	th ba	r	1	Qtz-l	4			19	1			70			3	2			1	
H5	th ba	a	1	Pl-p		12		10				63	1	t	12	1			1	
H6	th ba	a	1	Tur-v Qtz-l	2	t		20			t	64	2		2	2				t Tur
I1	ca rh	p	1	Qtz-l	7			78	5	5	t			2		1		t		t Tur,Grt
I2	ca rh	p																		
I3	ca rh	p																		
I4	ca rh	p	1	Qtz-l Pl-p f	1	4		61	7	12				10		2	t	t		t Hem
I5	ca rh	p																		
I6	ca rh	a	1	Qtz-l Pl-p f	1	3		71	10	5				5		5	t	t		
I7	ca rh	p																		
I8	ca rh	a																		
I9	ca rh	p																		

Abbreviations:

Irvine-Baragar classification: ca - calk-alkaline; th - tholeiitic; ba - basalt; an - andesite; da - dacite; rh - rhyolite; ha - high alumina; p - K poor series; a - K average series; r - K rich series;

ts #: sample number at site

Textures: p - phenocrysts; f - fragments; a - amygdales; v - veinlet; l - lens

Minerals: Qtz - quartz; Pl - plagioclase; Kfs - potash feldspar; Fs - feldspar; Qfm - quartz-feldspar matrix; Bt - biotite; Ms - muscovite; Chl - chlorite; Hbl - hornblende; Cum - cummingtonite; Cal - calcite; Ep - epidote; Opq - opaques; Ap - apatite; Zrn - zircon; Spn - sphene; Tur - tourmaline; Grt - garnet; Hem - hematite

Mineral abundances: estimated volume percent; t - trace

Table 2: Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Analyses by Geological Survey of Canada.

SiO_2 - Total: weight percent; Nb - V: parts per million by weight

Unit A - biotite dacite

	A 1-1	A 1-2	A 1-3	A 1-4	A 2-1	A 2-2	A 2-3	A 2-4	A 2-5	A 3-1	A 3-2	A 3-3	A 3-4
SiO_2	66.60	67.00	65.90	67.50	62.80	64.20	63.50	64.30	64.00	64.30	62.60	65.10	60.60
TiO_2	.46	.47	.44	.47	.76	.74	.76	.78	.76	.72	.74	.70	.80
Al_2O_3	15.20	15.50	16.20	15.30	15.10	13.50	15.80	16.10	13.50	15.10	15.00	15.30	15.70
Fe_2O_3	1.60	.70	1.00	.80	3.50	3.30	3.20	3.70	1.30	.80	.80	1.30	.90
FeO	1.80	2.90	2.60	2.70	2.20	2.30	2.10	2.00	1.90	4.30	4.20	3.40	4.80
MnO	.07	.05	.05	.06	.12	.10	.08	.07	.10	.08	.05	.06	.08
MgO	1.07	1.42	1.33	1.41	2.34	2.29	2.38	1.89	2.45	2.06	2.60	2.30	2.74
CaO	3.16	2.53	2.71	3.28	4.79	5.20	4.81	4.44	5.28	3.67	2.87	3.42	3.95
Na_2O	4.10	4.00	4.10	4.00	4.40	3.20	4.00	4.10	3.30	4.40	3.80	4.60	4.20
K_2O	2.04	2.41	2.51	2.28	1.99	1.98	1.86	2.12	2.03	1.81	3.33	1.96	2.19
H_2O	.80	1.10	1.10	.90	.60	.70	.70	.80	.80	.70	1.00	.80	1.10
CO_2	2.20	1.20	1.60	1.90	1.20	1.80	.40	.20	2.10	2.20	2.80	1.30	2.80
P_2O_5	.15	.16	.16	.15	.26	.24	.24	.27	.25	.26	.26	.25	.27
S	.01	.01	.00	.00	.02	.01	.00	.00	.05	.00	.00	.00	.00
Total	99.50	99.70	99.80	100.90	100.30	99.70	100.10	100.90	100.40	100.60	100.30	100.80	100.30
Nb	8	5	5	8	13	10	10	14	8	11	11	10	11
Rb	41	43	45	43	38	37	33	43	37	38	63	45	42
Sr	363	304	362	292	444	426	555	485	425	905	291	509	370
Y	7	7	6	9	17	10	12	19	15	9	10	12	12
Zr	136	145	135	138	189	175	192	198	174	174	179	188	188
Co	0	0	0	0	9	10	11	11	14	10	10	12	10
Cr	15	22	21	18	67	79	50	60	86	40	48	41	47
Ni	0	0	0	0	39	46	35	38	48	23	30	27	35
V	43	48	60	47	100	77	90	110	100	98	110	110	93

Table 2 (cont'd): Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Unit B - quartz feldspar porphyry

	B 1-1	B 2-1	B 3-1
SiO_2	74.00	73.10	64.50
TiO_2	.09	.16	.45
Al_2O_3	13.80	14.70	15.40
Fe_2O_3	.00	.80	.70
FeO	1.70	1.10	3.40
MnO	.00	.01	.06
MgO	.10	.49	1.02
CaO	1.18	.72	3.57
Na_2O	4.10	2.90	3.90
K_2O	3.36	3.50	3.01
H_2O	.50	1.10	1.10
CO_2	1.20	.90	2.90
P_2O_5	.03	.04	.14
S	.01	.36	.01
Total	100.30	100.20	100.40

Nb	12	11	8
Rb	69	57	70
Sr	226	167	245
Y	0	0	14
Zr	149	214	132
Co	0	0	9
Cr	0	0	12
Ni	0	0	0
V	0	48	63

Table 2 (cont'd): Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Unit C - andesite and basalt flows and breccia

	C 1-1	C 1-2	C 1-3	C 2-1	C 2-2	C 2-3	C 2-4	C 2-5	C 3-1	C 3-2	C 3-3	C 3-4	C 3-5	C 4-1	C 4-2
SiO_2	49.20	53.60	55.00	57.40	60.40	59.80	58.40	59.90	55.10	54.40	55.80	59.90	56.20	54.30	54.80
TiO_2	.84	.94	.92	.84	.74	.86	.89	.73	.86	.81	.80	.86	.95	.94	.90
Al_2O_3	15.50	16.30	15.80	16.40	15.20	16.30	16.10	15.20	17.20	16.60	16.20	16.70	17.30	19.10	17.90
Fe_2O_3	2.60	2.70	2.00	3.30	2.80	3.20	3.40	3.10	3.20	3.00	2.80	3.40	4.10	4.20	4.00
FeO	6.50	6.80	6.20	4.50	3.80	4.20	4.40	3.70	5.70	5.40	4.90	5.30	5.60	4.40	4.40
MnO	.16	.13	.16	.13	.11	.10	.11	.11	.12	.20	.15	.14	.16	.11	.10
MgO	6.34	5.39	5.03	4.26	3.90	3.86	4.20	3.96	4.39	4.27	4.01	2.62	2.88	3.20	3.27
CaO	9.82	7.25	7.85	6.78	6.58	5.62	5.68	6.62	6.33	8.56	6.82	6.22	7.56	5.88	5.98
Na_2O	3.00	2.90	3.30	3.40	3.20	3.10	2.70	3.70	3.20	3.40	3.20	3.10	2.10	3.10	2.40
K_2O	.77	1.18	.62	.69	.85	1.28	1.88	.85	1.56	.78	1.57	1.36	1.13	2.53	2.81
H_2O	1.50	1.40	1.10	1.00	.90	.80	1.00	.90	1.10	1.00	1.10	.80	.90	1.20	1.20
CO_2	3.00	1.30	1.60	.50	1.10	.10	.10	1.20	.10	1.40	2.10	.00	.10	.60	1.90
P_2O_5	.24	.30	.34	.26	.20	.23	.22	.21	.35	.24	.24	.35	.37	.27	.28
S	.01	.03	.00	.01	.01	.01	.01	.03	.02	.02	.02	.03	.06	.02	.01
Total	99.60	100.30	100.00	99.60	100.00	99.60	99.20	100.30	99.40	100.20	99.80	100.90	99.60	100.10	100.10
Nb	7	3	4	5	8	7	6	3	3	3	5	7	3	6	7
Rb	15	23	12	10	15	30	48	15	30	15	38	30	23	62	67
Sr	272	218	198	365	359	381	329	353	390	218	264	430	483	349	351
Y	26	27	26	23	18	20	19	14	25	22	20	21	22	26	25
Zr	117	127	122	127	116	133	130	112	130	132	134	136	138	154	143
Co	35	33	29	18	21	17	22	22	24	21	20	15	18	22	21
Cr	390	130	130	150	110	100	150	110	29	25	22	16	18	23	38
Ni	130	81	77	55	60	57	77	55	25	22	18	0	0	20	22
V	150	170	130	200	160	170	180	170	140	120	130	130	140	130	110

Table 2 (cont'd): Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Unit C - andesite and basalt flows and breccia

	C 4-3	C 4-4	C 4-5	C 5-1	C 5-2	C 5-3	C 5-4	C 5-5	C 6-1	C 6-2	C 6-3	C 6-4	C 7-1	C 7-2	C 7-3
SiO_2	52.40	52.70	51.40	53.30	53.00	57.30	55.10	56.80	59.80	55.70	56.60	60.00	56.30	55.60	58.10
TiO_2	.85	1.01	1.00	1.09	1.37	1.19	1.12	1.16	1.13	1.15	1.19	1.16	1.63	1.55	1.33
Al_2O_3	17.10	20.50	20.60	17.10	19.20	17.90	17.20	17.90	15.40	15.60	16.20	16.10	15.10	15.50	13.20
Fe_2O_3	2.50	4.40	4.40	4.90	6.00	5.30	6.00	5.20	5.00	3.50	4.30	5.00	5.90	4.20	3.90
FeO	5.20	5.10	4.90	3.30	3.50	3.20	2.80	3.10	3.30	3.90	3.50	2.30	4.00	3.60	3.60
MnO	.12	.10	.09	.12	.08	.07	.09	.07	.08	.10	.10	.08	.08	.07	.08
MgO	4.07	4.17	4.21	1.39	2.49	2.36	2.24	2.45	1.65	1.85	1.66	.92	2.21	2.52	3.15
CaO	5.54	4.28	4.23	7.61	4.14	3.55	5.35	3.65	3.58	6.78	5.75	4.27	4.11	4.37	4.25
Na_2O	2.30	4.20	5.50	3.50	4.10	3.90	3.10	4.80	2.10	3.20	3.10	2.60	2.80	3.20	3.10
K_2O	3.45	2.45	2.45	2.48	3.16	2.85	3.24	2.81	3.52	2.33	3.26	3.64	3.17	3.18	2.72
H_2O	1.40	1.30	1.20	.90	1.00	1.00	1.00	.90	1.10	.90	.90	1.10	1.00	1.00	.80
CO_2	3.80	.10	.10	4.00	.60	.90	2.60	.90	1.80	4.30	3.40	2.20	2.80	4.00	4.50
P_2O_5	.27	.30	.32	.40	.47	.43	.46	.43	.46	.46	.51	.50	.62	.59	.48
S	.02	.01	.04	.00	.00	.02	.01	.04	.00	.01	.01	.01	.00	.01	.00
Total	99.20	100.70	100.60	100.30	99.30	100.10	100.50	100.40	99.10	99.90	100.70	100.10	99.90	99.80	99.40
Nb	8	6	4	13	14	15	13	13	19	14	13	16	25	23	18
Rb	66	48	44	55	78	69	71	64	94	68	95	88	97	99	86
Sr	120	332	321	315	321	224	265	223	185	241	243	197	204	170	177
Y	23	23	20	33	38	35	36	34	30	34	38	35	60	65	53
Zr	162	147	142	221	303	334	221	337	301	281	252	325	467	468	383
Co	24	27	26	13	29	12	15	22	12	13	13	10	14	13	11
Cr	19	23	22	14	20	15	16	17	26	22	20	19	12	11	9
Ni	23	22	16	17	31	19	19	27	26	25	27	20	18	0	0
V	77	140	140	93	110	100	110	150	93	100	91	83	120	91	100

Table 2 (cont'd): Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Unit C - andesite and basalt flows and breccia

	C 7-4	C 8-1	C 8-2	C 8-3	C 8-4	C 8-5	C 9-1	C 9-2	C 9-3	C 9-4
SiO_2	61.10	59.70	57.90	60.70	61.60	59.10	61.70	61.30	57.10	60.70
TiO_2	1.38	1.15	1.31	1.18	1.15	1.13	1.17	1.14	1.42	1.10
Al_2O_3	13.70	14.70	17.30	15.00	14.80	15.10	15.30	14.40	18.00	14.40
Fe_2O_3	4.70	2.90	3.70	3.60	4.60	3.20	4.30	4.50	5.80	4.00
FeO	3.40	5.10	5.60	4.70	4.50	4.90	3.90	3.90	4.00	3.90
MnO	.06	.08	.08	.06	.08	.07	.07	.06	.05	.09
MgO	1.97	2.27	1.47	1.94	.94	2.31	1.81	1.16	2.14	1.98
CaO	3.11	3.45	2.30	3.02	3.03	3.43	2.55	2.57	1.89	3.49
Na_2O	2.90	3.20	3.90	3.90	4.30	3.60	3.70	4.60	1.30	3.50
K_2O	3.11	3.31	5.05	3.18	2.22	3.33	3.00	2.51	6.00	2.58
H_2O	.80	.70	.60	.70	.50	.70	.70	.50	1.80	.70
CO_2	2.40	2.50	.20	1.80	1.70	2.50	1.20	2.10	.60	2.60
P_2O_5	.53	.43	.49	.45	.42	.45	.44	.42	.51	.44
S	.01	.02	.01	.01	.05	.01	.00	.01	.01	.01
Total	99.30	99.70	100.10	100.50	100.20	100.00	100.20	99.40	100.90	99.50

Nb	20	29	34	27	26	29	30	28	34	28
Rb	91	120	153	112	53	115	93	61	147	74
Sr	163	151	183	179	170	147	165	135	119	157
Y	52	71	81	76	68	68	72	72	88	66
Zr	418	573	672	605	611	560	612	582	700	542
Co	12	11	12	7	11	12	11	10	9	11
Cr	9	8	13	8	9	7	8	8	10	8
Ni	0	0	0	0	0	0	0	0	0	0
V	86	0	0	0	0	33	0	0	0	0

Table 2 (cont'd): Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Unit D - tuff

	D 1-1	D 1-2	D 1-3	D 1-4
SiO_2	67.90	67.50	66.70	67.70
TiO_2	.28	.28	.28	.27
Al_2O_3	14.90	15.20	15.30	14.50
Fe_2O_3	.90	.50	1.00	1.30
FeO	3.70	4.10	3.60	3.50
MnO	.09	.10	.09	.10
MgO	.62	.42	.49	.41
CaO	2.43	2.61	2.58	2.49
Na_2O	3.80	4.00	4.00	3.60
K_2O	3.29	3.09	3.15	3.13
H_2O	.70	.60	.80	.70
CO_2	1.90	2.10	2.30	2.50
P_2O_5	.07	.07	.09	.07
S	.01	.00	.02	.00
Total	100.80	100.70	100.50	100.50

Nb	20	12	18	18
Rb	71	68	74	69
Sr	97	104	117	118
Y	58	59	62	60
Zr	379	394	402	382
Co	0	0	0	0
Cr	6	6	8	12
Ni	0	0	0	0
V	0	0	0	0

Table 2 (cont'd): Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Unit E - rhyolite

	E 1-1	E 1-2	E 1-3	E 1-4	E 2-1	E 2-2	E 2-3	E 2-4	E 3-1
SiO_2	66.40	69.20	66.60	63.80	68.00	67.50	67.90	68.10	68.10
TiO_2	.30	.28	.41	.63	.26	.30	.28	.27	.28
Al_2O_3	16.00	14.70	13.70	14.80	14.40	15.30	14.50	14.70	14.90
Fe_2O_3	3.00	2.80	1.50	1.10	3.40	4.50	4.70	4.40	3.70
FeO	2.30	2.30	3.50	4.60	1.00	.70	.00	.70	1.60
MnO	.05	.06	.10	.09	.10	.06	.08	.08	.07
MgO	.26	.23	.91	1.46	.29	.22	.29	.32	.40
CaO	1.76	1.89	3.72	3.28	2.62	2.10	2.70	2.28	1.83
Na_2O	3.60	3.40	2.80	2.30	3.40	4.00	4.00	3.20	4.80
K_2O	4.05	3.17	2.78	3.47	2.89	2.87	2.44	3.23	2.49
H_2O	.70	.70	.80	1.10	.70	.70	.70	.80	.60
CO_2	1.00	1.40	2.90	2.80	2.20	1.70	2.30	1.80	1.30
P_2O_5	.07	.08	.12	.17	.06	.09	.08	.08	.07
S	.00	.00	.00	.01	.00	.00	.00	.00	.01
Total	99.70	100.40	100.10	99.80	99.60	100.20	100.20	100.20	100.30

Nb	19	18	14	19	15	16	15	15	19
Rb	82	67	74	90	73	69	58	82	61
Sr	138	119	141	118	99	118	117	93	130
Y	57	59	47	24	55	56	58	59	62
Zr	419	399	287	223	368	364	363	383	400
Co	0	0	0	13	0	0	0	0	0
Cr	7	0	8	10	0	0	8	8	9
Ni	0	0	0	0	0	0	0	0	0
V	0	0	0	41	0	0	0	0	90

Table 2 (cont'd): Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Unit F - andesite and basalt flows and breccia

	F 1-1	F 1-2	F 2-1	F 2-2	F 2-3	F 2-4	F 3-1	F 3-2	F 3-3	F 3-4	F 4-1	F 4-2	F 4-3	F 4-4	F 5-1
SiO_2	51.00	50.20	53.70	53.40	53.40	53.70	51.40	51.50	54.80	51.10	51.50	52.60	52.60	50.40	50.30
TiO_2	1.05	1.08	.82	.75	.89	.80	1.58	1.54	1.34	1.62	1.50	1.45	1.48	1.44	1.10
Al_2O_3	17.30	16.90	15.90	15.80	15.70	16.30	15.10	15.10	15.30	15.50	15.30	15.40	15.10	14.70	16.20
Fe_2O_3	2.80	3.40	3.20	3.10	3.50	3.40	6.40	4.40	4.30	5.50	5.40	5.20	5.40	6.10	5.80
FeO	8.70	7.50	5.60	5.30	5.80	5.80	6.80	8.50	7.20	7.10	8.40	8.10	8.40	7.40	6.10
MnO	.19	.18	.15	.15	.16	.14	.21	.21	.18	.19	.18	.20	.22	.23	.18
MgO	5.19	4.67	5.39	5.19	5.18	5.29	2.90	3.47	2.83	4.02	4.32	4.25	4.25	4.10	3.70
CaO	9.44	9.06	7.63	8.66	8.70	8.50	7.75	7.47	5.58	6.55	7.19	8.19	8.18	8.47	8.48
Na_2O	1.90	2.30	3.10	2.60	2.90	2.60	2.80	2.90	3.40	2.70	2.10	2.60	2.30	2.70	3.40
K_2O	.62	.92	1.33	1.13	1.08	1.30	.93	1.37	1.56	1.26	1.06	.46	.40	.73	.77
H_2O	1.20	1.30	1.20	1.20	1.20	1.20	.90	1.10	.90	1.00	1.10	1.10	1.10	1.00	.80
CO_2	.60	1.60	.50	1.30	1.40	.80	3.20	3.00	2.50	3.10	.70	.90	.80	2.90	3.00
P_2O_5	.19	.20	.18	.17	.21	.18	.24	.23	.24	.23	.23	.23	.22	.21	.14
S	.00	.02	.06	.02	.02	.00	.02	.02	.02	.02	.01	.01	.01	.01	.00
Total	100.20	99.50	98.90	98.90	100.40	100.10	100.40	100.90	100.20	100.10	99.20	100.80	100.40	100.50	100.10
Nb	9	10	18	18	19	16	10	9	12	8	8	9	10	9	8
Rb	19	17	22	16	21	35	20	29	39	27	32	11	8	18	21
Sr	235	332	229	243	230	278	245	201	151	179	210	224	253	190	148
Y	37	40	63	57	68	58	47	49	48	51	45	44	42	48	33
Zr	113	122	169	175	190	171	188	187	215	186	175	172	170	173	128
Co	35	38	30	31	32	34	35	33	22	32	34	36	37	31	34
Cr	13	15	35	34	37	40	13	12	9	11	15	15	16	14	59
Ni	21	27	38	38	37	41	0	0	0	0	0	16	0	0	21
V	180	180	130	130	150	150	200	210	86	220	210	200	220	210	220

Table 2 (cont'd): Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Unit F - andesite and basalt flows and breccia

	F 5-2	F 5-3	F 5-4	F 5-5	F 6-1	F 6-2	F 6-3	F 6-4	F 7-1	F 7-2	F 7-3	F 7-4	F 8-1	F 8-2	F 8-3
SiO_2	50.80	56.70	54.20	55.70	53.40	56.40	53.70	54.30	63.80	57.70	59.80	59.90	57.50	58.30	57.90
TiO_2	.92	1.28	1.31	1.25	1.10	.96	.99	1.05	.47	.94	.73	.92	.94	.95	.95
Al_2O_3	17.10	15.30	15.80	15.30	17.40	15.20	15.70	16.80	11.00	17.10	16.80	16.40	16.50	16.80	16.70
Fe_2O_3	2.90	5.40	4.80	5.20	4.90	4.20	4.50	5.70	2.10	3.90	3.00	3.50	3.10	2.50	3.00
FeO	8.50	5.70	7.20	5.90	6.10	5.20	5.30	5.30	2.80	4.30	3.60	4.20	5.10	5.80	5.10
MnO	.21	.18	.20	.19	.14	.17	.18	.14	.13	.12	.11	.12	.13	.13	.13
MgO	5.64	2.66	3.27	2.72	3.99	3.91	3.92	3.47	.56	2.96	2.63	4.02	3.59	3.77	3.31
CaO	9.18	6.33	7.83	6.39	8.16	7.70	8.60	6.64	8.74	7.70	6.74	4.76	6.87	7.50	6.77
Na_2O	2.70	3.00	2.60	3.50	2.70	3.20	2.70	3.90	1.90	3.10	2.30	3.30	3.10	2.20	3.60
K_2O	.36	.81	.43	.78	.28	.55	1.10	.84	.92	.96	1.72	.89	.20	1.09	.37
H_2O	1.40	.80	1.00	.90	1.00	.90	1.00	.80	.70	.80	.90	1.30	1.00	1.00	1.00
CO_2	.60	1.60	1.30	1.70	.10	1.80	2.50	1.10	6.70	.30	1.50	.00	.30	.40	.40
P_2O_5	.13	.23	.21	.24	.19	.22	.17	.14	.11	.19	.15	.18	.18	.19	.18
S	.00	.00	.03	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00
Total	100.60	100.10	100.30	99.90	99.60	100.50	100.50	100.20	100.00	100.20	100.20	99.70	98.60	100.90	99.60
Nb	3	9	12	10	8	9	12	8	15	13	16	12	16	14	13
Rb	4	21	8	24	2	8	25	14	41	33	67	28	2	37	9
Sr	250	148	227	149	393	198	159	191	151	347	248	216	334	423	345
Y	31	38	43	37	27	25	30	29	16	20	19	20	24	20	22
Zr	86	163	186	155	157	163	127	155	204	172	177	171	177	173	176
Co	32	22	22	27	36	36	41	32	0	23	24	29	26	27	24
Cr	34	11	10	13	20	18	20	22	9	12	13	13	20	20	18
Ni	71	0	0	0	25	21	24	25	0	0	18	0	29	27	19
V	170	150	170	190	190	180	180	190	77	120	130	120	110	120	110

Table 2 (cont'd): Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Unit F - andesite and basalt flows and breccia

	F 8-4	F 9-1	F 9-2	F 9-3	F 9-4	F 9-5	F 9-6	F10-1	F10-2	F10-3	F10-4	F10-5	F10-6	F11-1	F11-2
SiO_2	56.70	52.50	53.90	53.90	59.80	59.50	51.70	60.80	59.10	59.80	62.10	60.30	59.80	47.90	52.40
TiO_2	.97	1.23	1.08	1.10	1.05	1.08	1.23	.99	.97	.95	1.13	1.15	.98	1.31	1.31
Al_2O_3	17.20	15.00	16.70	16.60	16.50	16.80	14.90	16.40	16.70	16.70	15.70	16.20	16.70	15.60	15.20
Fe_2O_3	3.60	5.90	4.70	5.00	5.80	3.90	5.70	4.30	3.90	3.90	4.30	4.80	4.40	7.40	6.00
FeO	4.70	5.10	6.00	5.50	2.90	4.80	5.50	4.10	4.10	3.90	4.10	3.90	4.10	5.80	5.80
MnO	.13	.18	.16	.14	.12	.12	.18	.13	.13	.13	.10	.14	.14	.25	.19
MgO	3.10	3.95	4.70	4.50	3.06	3.35	4.04	2.19	2.27	2.18	1.49	1.93	2.36	3.55	3.26
CaO	6.83	7.44	8.58	8.31	5.65	4.89	7.52	5.93	6.62	6.84	3.99	4.95	5.94	8.37	7.12
Na_2O	2.70	2.90	1.70	1.60	2.70	3.00	3.00	2.60	2.50	2.90	4.10	3.90	2.90	3.00	1.60
K_2O	1.98	.94	.14	.18	1.35	1.54	.93	1.41	1.53	1.43	1.33	1.31	1.46	1.26	2.27
H_2O	1.10	.90	1.60	1.60	1.10	1.20	.90	.70	.90	.90	.50	.70	.80	.90	1.00
CO_2	1.50	4.40	.10	.10	.30	.20	4.40	.10	.20	.30	.40	1.20	.10	4.50	2.90
P_2O_5	.19	.21	.17	.16	.20	.21	.24	.17	.19	.18	.23	.27	.19	.22	.24
S	.00	.00	.00	.00	.00	.00	.03	.00	.00	.00	.00	.00	.03	.00	.00
Total	100.90	100.70	99.60	98.80	100.60	100.70	100.40	100.00	99.20	100.30	99.70	100.90	100.10	100.30	99.50
Nb	16	7	7	10	15	14	12	16	18	16	15	19	17	11	15
Rb	73	19	0	1	47	52	25	41	52	45	56	49	40	45	76
Sr	166	159	250	294	240	227	170	279	292	289	213	229	270	224	213
Y	25	40	29	28	28	29	44	28	27	26	28	34	27	36	38
Zr	177	147	143	153	213	221	161	196	197	184	195	216	197	224	182
Co	25	31	32	32	22	28	34	15	20	19	14	16	21	43	31
Cr	17	22	19	20	11	12	23	10	11	11	10	10	12	16	14
Ni	19	30	26	24	0	0	29	0	0	0	0	0	0	27	22
V	120	240	200	190	160	160	230	130	130	120	130	120	110	210	180

Table 2 (cont'd): Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Unit F - andesite and basalt flows and breccia

	F11-3	F11-4
SiO_2	48.30	52.60
TiO_2	1.39	1.22
Al_2O_3	16.40	14.50
Fe_2O_3	9.40	7.40
FeO	3.30	6.00
MnO	.22	.16
MgO	2.97	3.64
CaO	8.94	5.90
Na_2O	1.70	3.60
K_2O	2.75	.83
H_2O	1.20	.90
CO_2	3.50	3.30
P_2O_5	.25	.26
S	.00	.00
Total	100.40	100.40

Nb	14	14
Rb	87	19
Sr	194	186
Y	34	38
Zr	188	158
Co	34	37
Cr	15	14
Ni	24	25
V	170	170

Table 2 (cont'd): Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Unit G - welded tuff

	G 1-1	G 1-2	G 2-1	G 3-1	G 4-1	G 5-1	G 6-1	G 7-1	G 8-1	G 9-1	G 9-2	G10-1	G10-2	G10-3	G10-4
SiO_2	72.90	52.10	73.60	72.50	73.90	74.10	76.80	75.80	68.80	75.10	74.10	75.40	72.20	72.30	76.70
TiO_2	.14	1.36	.15	.14	.15	.14	.12	.15	.14	.16	.17	.18	.46	.43	.11
Al_2O_3	13.50	15.90	13.50	13.90	13.50	13.70	11.60	13.30	16.40	12.30	12.60	12.20	12.20	12.30	11.70
Fe_2O_3	1.60	1.50	1.20	1.20	1.80	1.80	.80	1.20	.90	1.10	1.00	1.10	2.00	2.20	.90
FeO	.70	.70	1.10	1.00	.50	.50	1.10	.80	1.30	1.20	1.00	1.30	1.90	1.90	.90
MnO	.05	.19	.06	.05	.05	.06	.05	.03	.04	.04	.04	.05	.08	.09	.04
MgO	.14	5.33	.10	.16	.14	.07	.33	.21	.54	.55	.63	.11	.21	.14	.30
CaO	.94	11.00	1.20	.98	1.01	.99	1.05	.36	1.35	.97	.98	.99	1.71	1.72	1.04
Na_2O	3.00	1.50	3.40	4.20	3.80	2.70	4.00	3.10	5.20	3.10	3.70	3.20	2.90	3.10	3.90
K_2O	5.13	.19	4.59	4.54	4.63	4.68	2.55	4.11	3.42	3.28	3.26	4.49	3.89	3.90	2.45
H_2O	.40	.40	.30	.40	.30	.40	.30	.50	.60	.40	.50	.20	.30	.30	.40
CO_2	.90	1.00	1.20	1.00	.90	.70	1.20	.10	1.40	1.50	1.80	1.00	1.40	1.50	1.30
P_2O_5	.04	.11	.02	.03	.02	.02	.02	.03	.02	.03	.03	.03	.14	.15	.03
S	.00	.00	.00	.00	.00	.00	.04	.00	.00	.00	.00	.00	.00	.00	.02
Total	99.60	99.30	100.60	100.30	100.80	100.10	100.10	99.80	100.20	99.90	99.80	100.40	99.60	100.30	99.90
Nb	19	17	19	22	21	19	19	22	21	21	20	18	14	15	16
Rb	163	156	151	168	160	159	81	163	102	110	104	116	111	111	79
Sr	51	48	43	53	49	39	37	41	78	36	36	76	108	108	36
Y	70	67	71	66	69	76	55	57	90	67	65	72	63	64	51
Zr	260	245	258	270	263	266	221	267	278	237	232	371	384	371	218
Co	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0
Cr	0	0	0	0	0	0	20	0	0	0	0	0	6	0	0
Ni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V	0	0	45	54	51	0	36	0	33	0	0	0	0	0	0

Table 2 (cont'd): Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Unit H - basalt flows and breccia

	H 1-1	H 1-2	H 1-3	H 1-4	H 2-1	H 2-2	H 2-3	H 3-1	H 3-2	H 3-3	H 3-4	H 3-5	H 4-1	H 4-2	H 4-3
SiO_2	54.20	52.80	54.60	54.20	54.60	51.30	55.10	54.50	53.90	59.00	62.10	55.10	53.20	54.70	52.00
TiO_2	1.41	1.37	1.37	1.46	1.46	1.56	1.47	1.39	1.40	1.20	1.39	1.39	1.12	.99	1.06
Al_2O_3	15.30	14.70	15.10	14.90	15.50	16.20	15.00	15.20	15.50	15.00	13.40	15.40	14.50	15.40	15.50
Fe_2O_3	5.40	11.70	7.00	5.10	4.90	4.80	4.00	3.50	4.00	3.90	3.60	3.70	4.10	3.40	3.80
FeO	6.10	1.00	5.40	6.80	7.50	8.00	7.80	8.40	8.00	5.40	6.10	8.20	8.40	8.00	8.10
MnO	.16	.18	.19	.18	.19	.24	.22	.18	.20	.14	.13	.19	.20	.17	.19
MgO	2.78	2.30	2.43	2.91	3.93	4.61	3.87	3.97	4.26	2.88	3.17	4.23	4.93	4.36	4.76
CaO	6.00	6.77	6.17	5.39	6.33	8.15	7.96	7.79	8.79	6.00	5.62	7.76	9.14	9.15	9.74
Na_2O	3.50	3.10	3.40	3.30	2.40	2.40	2.20	1.60	2.50	3.40	2.00	2.00	2.30	2.40	1.70
K_2O	1.80	1.74	.90	1.29	1.46	.95	.56	1.11	.59	1.24	1.38	1.12	.50	.47	.48
H_2O	.80	.60	.60	.70	1.00	1.20	.90	1.10	.80	.70	.80	1.00	1.00	1.00	1.00
CO_2	2.40	3.80	1.70	2.20	.20	.10	.00	.00	.10	.80	.10	.10	.10	.10	.10
P_2O_5	.24	.26	.23	.24	.28	.29	.27	.25	.27	.23	.29	.26	.13	.12	.11
S	.00	.00	.00	.00	.03	.04	.04	.04	.02	.03	.04	.02	.05	.03	.04
Total	100.20	100.40	99.20	98.90	99.90	99.90	99.50	99.10	100.30	100.00	100.20	100.60	99.70	100.30	98.70
Nb	11	14	14	15	6	7	8	6	7	4	5	6	3	4	3
Rb	32	48	26	44	35	24	15	27	9	30	40	25	1	1	4
Sr	128	154	237	171	154	208	214	216	188	130	167	213	106	116	124
Y	58	45	57	56	48	54	60	57	56	41	56	51	36	37	36
Zr	212	205	217	205	182	199	191	189	192	168	182	179	94	89	90
Co	41	29	28	37	32	34	31	30	30	25	29	37	44	38	35
Cr	13	12	11	17	33	33	30	32	36	40	31	31	39	35	33
Ni	0	0	0	15	39	45	39	38	41	38	40	39	52	46	45
V	190	170	150	180	150	150	150	150	170	130	140	180	240	210	200

Table 2 (cont'd): Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Unit H - basalt flows and breccia

	H 4-4	H 4-5	H 4-6	H 5-1	H 5-2	H 5-3	H 5-4	H 5-5	H 6-1	H 6-2
SiO_2	52.50	53.50	52.10	50.80	51.60	51.50	53.80	54.00	52.40	52.90
TiO_2	.90	1.04	.90	.74	.79	.86	.79	.80	.65	.68
Al_2O_3	18.80	15.20	18.70	15.90	15.40	17.10	15.20	15.20	16.50	16.50
Fe_2O_3	3.10	3.50	2.90	3.90	4.30	3.90	3.60	3.50	3.00	2.90
FeO	6.80	8.40	6.80	6.40	6.80	6.60	7.10	7.30	6.70	6.20
MnO	.14	.19	.14	.24	.25	.21	.21	.22	.16	.17
MgO	4.04	4.71	4.07	7.06	6.28	5.99	5.82	5.82	6.81	6.74
CaO	8.55	9.00	8.52	11.10	10.10	9.81	9.03	9.16	9.63	10.20
Na_2O	2.60	1.90	2.80	2.60	2.50	2.60	2.50	2.10	2.30	2.00
K_2O	1.37	.45	1.35	.34	.36	.40	.36	.34	.35	.27
H_2O	1.20	1.10	1.10	1.20	1.00	1.00	1.10	1.10	1.00	1.10
CO_2	.30	.10	.20	.10	.10	.00	.70	.70	.00	.00
P_2O_5	.11	.12	.11	.12	.12	.11	.12	.12	.08	.08
S	.04	.01	.00	.00	.00	.00	.01	.00	.00	.00
Total	100.50	99.20	99.90	100.60	99.60	100.10	100.40	100.40	99.80	99.90

Nb	1	3	0	4	2	2	6	4	3	0
Rb	57	1	55	1	2	8	4	4	3	0
Sr	170	111	171	168	148	187	146	149	160	165
Y	26	39	28	26	27	25	26	28	20	17
Zr	68	87	76	77	79	66	97	95	68	66
Co	37	37	0	36	36	39	42	42	37	40
Cr	30	43	0	49	52	42	61	59	110	100
Ni	47	55	0	51	53	66	60	59	62	64
V	190	200	0	200	190	210	180	210	190	230

Table 2 (cont'd): Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Unit I - quartz eye granite

	I 1-1	I 2-1	I 2-2	I 2-3	I 3-1	I 4-1	I 4-2	I 5-1	I 6-1	I 7-1	I 8-1	I 9-1
SiO_2	71.80	71.30	72.20	71.10	71.20	69.30	70.90	72.30	70.50	71.50	69.90	71.20
TiO_2	.21	.25	.21	.23	.23	.23	.26	.23	.23	.24	.25	.26
Al_2O_3	14.00	13.90	13.40	13.50	13.90	14.10	13.80	13.20	13.50	13.60	13.90	14.00
Fe_2O_3	.20	.40	1.80	1.90	2.30	.60	.30	1.40	.60	.50	1.80	.50
FeO	2.90	2.50	1.40	1.20	.90	2.40	3.00	1.70	2.40	2.70	1.80	2.90
MnO	.07	.05	.05	.07	.06	.05	.06	.05	.06	.06	.06	.06
MgO	.21	.18	.16	.02	.25	.23	.14	.23	.32	.21	.29	.28
CaO	1.82	1.76	1.72	1.53	1.52	2.02	1.58	1.67	1.94	1.88	1.75	1.60
Na_2O	3.60	3.50	4.80	3.70	3.80	4.50	6.50	4.80	3.60	3.90	3.80	5.80
K_2O	2.89	3.80	1.81	3.26	3.28	3.12	1.55	1.81	4.06	3.57	4.18	1.53
H_2O	.70	.70	.70	.90	.90	.90	.50	.60	.60	.70	.60	.60
CO_2	1.10	1.90	1.80	1.80	1.80	2.50	1.60	1.80	1.90	1.60	1.90	1.60
P_2O_5	.04	.06	.05	.06	.04	.04	.07	.03	.05	.05	.06	.06
S	.09	.00	.00	.00	.05	.09	.05	.03	.16	.03	.14	.05
Total	99.80	100.40	100.20	99.50	100.40	100.30	100.40	99.90	100.10	100.70	100.70	100.50
Nb	17	14	12	14	15	15	15	14	14	18	16	15
Rb	68	93	54	81	79	91	34	57	107	93	120	37
Sr	152	95	84	145	145	104	71	87	97	88	79	73
Y	49	45	40	47	46	39	47	45	46	46	46	48
Zr	269	281	253	277	272	267	291	260	264	279	270	293
Co	0	0	0	0	0	0	0	0	0	0	0	0
Cr	5	0	6	0	0	0	0	18	5	0	9	0
Ni	0	0	0	0	0	0	0	0	0	0	0	0
V	0	0	0	0	0	0	0	0	0	0	0	0

Table 3: Accuracy of analyses - Geological Survey of Canada Analytical Chemistry Section 21/10/1983

Element	Calibration range %	Total maximum error absolute + relative %		Determination limit	Standard deviation
SiO_2	0 - 100	0.40	1	0.40	0.53
TiO_2	0 - 3	0.02	1	0.02	0.02
Al_2O_3	0 - 60	0.40	1	0.40	0.40
Fe_2O_3	0 - 90	0.10	1	0.10	0.10
FeO	0 - 30	0.03	2	0.03	
MnO	0 - 1	0.01	2	0.01	0.01
MgO	0 - 50	0.10	1	0.10	0.14
CaO	0 - 35	0.10	1	0.10	0.15
Na_2O	0 - 10	0.50	2	0.50	0.50
K_2O	0 - 15	0.05	1	0.05	0.16
H_2O	0 - 5	0.05	5	0.05	
CO_2	0 - 20	0.02	3	0.02	
P_2O_5	0 - 1	0.02	1	0.02	0.02
S	0 - 3	0.02	5	0.02	

Nb, Rb, Sr, Y, and Zr are accurate to +/- 10 ppm, +/- 10 %
Co, Cr, Ni, and V are accurate to +/- 15 %

Table 4: Detection limits (ppm) - Neutron Activation Services Limited 18/03/1985

U	0.1	As	1.0	Hf	0.2	Sm	0.01
Th	0.2	Sb	0.1	Ta	0.5	Eu	0.05
Sc	0.01	Cs	0.2	W	1.0	Tb	0.1
Co	0.1	Ba	20.0	Ce	1.0	Yb	0.05
Zn	5.0	La	0.1	Nd	3.0	Lu	0.01

Table 5: Trace element geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba

Analyses by Neutron Activation Services, Hamilton, Ontario.
Concentrations in parts per million.

	A 1-1	A 3-1	A 3-1	B 1-1	C 4-2	C 7-2	C 8-4	C 8-4	C 9-2	E 1-2	E 1-3	E 3-1	E 3-1	F 4-1	F 5-2
U	2.30	3.30	3.30	4.70	3.00	5.30	5.60	6.00	6.40	3.70	4.50	3.40	2.90	1.40	.90
Th	4.10	5.80	5.30	7.40	4.90	11.00	12.00	12.00	12.00	8.40	7.50	8.60	7.80	2.70	1.00
Sc	7.90	13.00	13.00	.57	22.00	21.00	16.00	18.00	18.00	8.40	10.00	9.50	8.70	39.00	37.00
Co	7.50	14.00	13.00	1.20	29.00	20.00	15.00	17.00	15.00	3.10	9.00	2.70	2.40	48.00	41.00
Zn	110.00	150.00	160.00	130.00	230.00	240.00	160.00	160.00	160.00	150.00	160.00	160.00	130.00	300.00	260.00
As	1.00	2.00	2.00	5.00	3.00	3.00	3.00	2.00	2.00	1.00	2.00	1.00	1.00	1.00	5.00
Sb	.50	3.10	2.90	1.10	.60	1.50	.70	.70	1.00	1.40	1.30	1.10	1.00	.70	1.10
Cs	1.10	1.30	1.10	1.20	1.80	3.10	1.10	.80	1.40	.80	2.30	2.40	1.70	1.50	.00
Ba	670.00	740.00	750.00	1500.00	570.00	940.00	1000.00	1200.00	1100.00	950.00	840.00	930.00	910.00	450.00	110.00
La	21.90	35.60	35.20	27.70	25.30	60.60	62.90	68.10	66.10	46.90	37.50	46.70	43.80	19.80	6.60
Hf	3.00	5.00	4.70	4.90	4.10	11.00	12.00	13.00	12.00	10.00	7.40	9.60	9.00	4.30	2.10
Ta	.50	.60	.80	.80	.00	1.30	1.60	1.50	1.70	1.70	1.40	1.10	1.50	.60	.50
W	2.00	2.00	7.00	6.00	7.00	4.00	2.00	11.00	5.00	5.00	4.00	5.00	6.00	.00	1.00
Ce	42.00	69.00	69.00	59.00	56.00	129.00	134.00	145.00	145.00	97.00	76.00	97.00	88.00	44.00	18.00
Nd	17.00	29.00	30.00	29.00	25.00	57.00	59.00	62.00	63.00	42.00	33.00	41.00	39.00	25.00	10.00
Sm	3.39	5.93	5.75	5.62	6.01	12.20	12.10	13.30	12.90	9.52	7.27	9.49	8.59	5.77	3.29
Eu	.84	1.41	1.51	1.15	1.49	2.18	2.22	2.05	2.50	1.76	1.48	1.71	1.68	1.80	1.06
Tb	.40	.60	.60	.00	.80	1.50	1.90	1.80	1.80	1.50	1.20	1.50	1.40	1.00	.70
Yb	1.01	1.62	1.44	.00	2.97	6.44	6.25	6.86	6.81	5.74	4.63	5.68	5.32	4.43	3.25
Lu	.17	.26	.26	.00	.48	.97	1.02	1.11	1.08	.89	.76	.91	.83	.68	.49

	F 6-1	F 8-1	G 1-1	G 8-1	H 2-1	H 2-1	H 4-1	H 6-1	I 1-1	I 2-1	I 9-1
U	1.70	3.20	6.70	7.70	1.40	1.20	.70	.70	5.50	4.60	5.40
Th	3.10	4.20	13.00	13.00	2.40	2.30	1.10	1.40	11.00	11.00	12.00
Sc	34.00	20.00	3.60	4.10	35.00	35.00	50.00	42.00	4.90	5.60	5.90
Co	39.00	28.00	1.60	1.90	40.00	41.00	50.00	47.00	3.60	4.80	3.00
Zn	160.00	130.00	60.00	44.00	250.00	350.00	270.00	330.00	110.00	89.00	100.00
As	1.00	1.00	2.00	3.00	11.00	11.00	8.00	5.00	120.00	37.00	19.00
Sb	.30	.60	2.80	1.20	1.10	1.00	2.30	2.30	1.30	1.80	.50
Cs	.00	.70	1.30	1.40	3.20	3.30	.20	.50	4.10	2.20	.70
Ba	150.00	410.00	1000.00	1000.00	820.00	790.00	170.00	130.00	1400.00	1100.00	920.00
La	18.00	21.00	36.30	40.30	17.10	16.80	7.80	4.70	44.80	47.10	46.30
Hf	3.50	4.00	7.30	7.80	4.60	4.70	2.30	1.90	7.60	7.50	8.30
Ta	.60	1.30	3.00	2.60	.00	.70	.00	.00	1.60	1.00	1.60
W	2.00	2.00	6.00	9.00	.00	4.00	3.00	.00	3.00	4.00	4.00
Ce	39.00	44.00	75.00	82.00	40.00	41.00	20.00	12.00	87.00	88.00	91.00
Nd	20.00	22.00	31.00	33.00	22.00	21.00	12.00	6.00	36.00	39.00	37.00
Sm	4.55	4.52	7.30	8.26	5.53	5.59	3.60	1.99	7.62	7.78	7.84
Eu	1.24	1.15	.95	.97	1.45	1.41	.99	.65	.99	1.18	1.27
Tb	.70	.80	1.40	1.60	1.00	1.20	.70	.40	1.10	1.30	1.10
Yb	3.26	2.54	6.98	7.56	4.65	4.48	4.02	2.22	4.25	4.74	4.94
Lu	.52	.43	1.13	1.27	.72	.71	.63	.35	.81	.75	.79

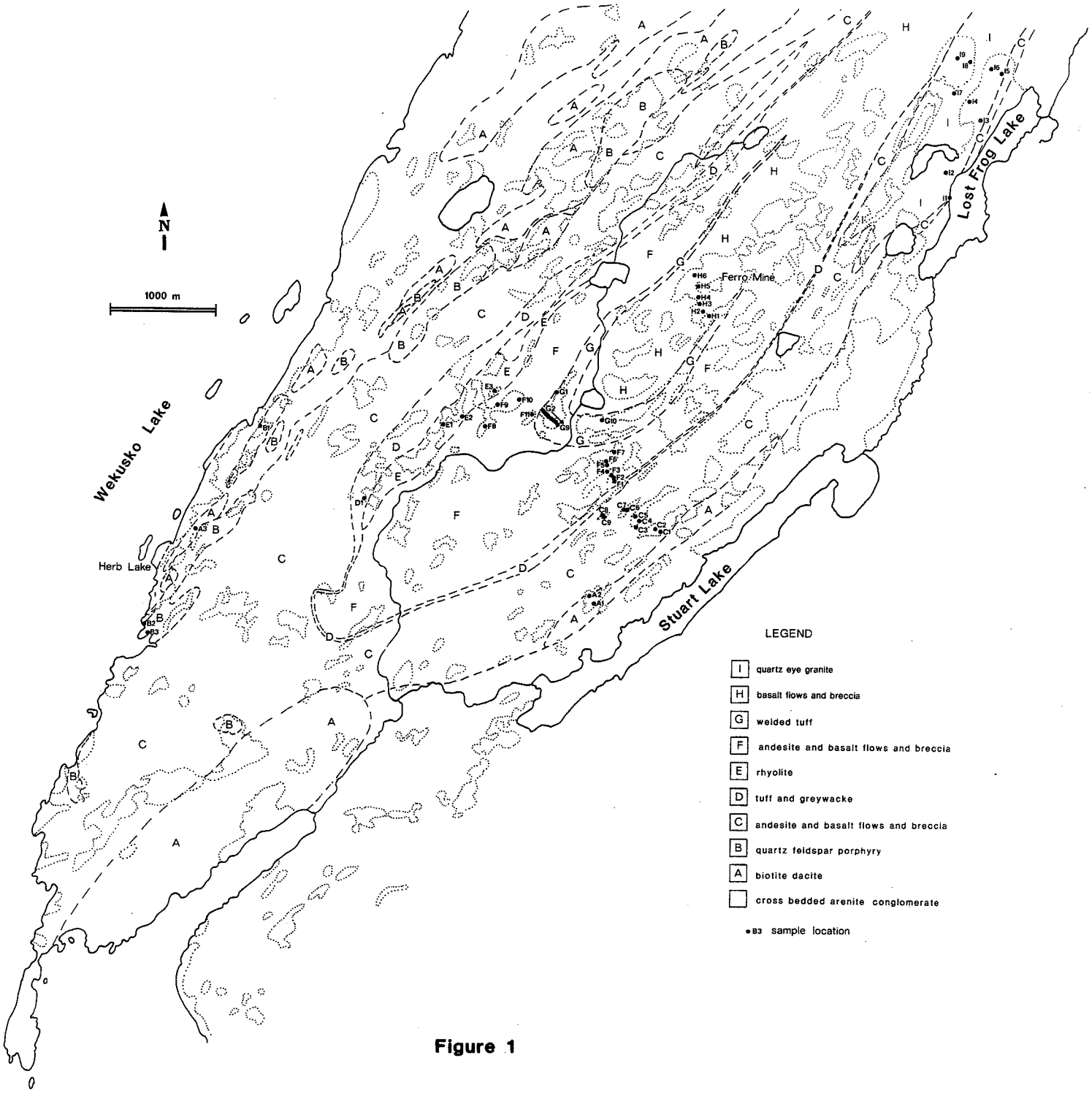
N
1000 m
Wekusko Lake
Herb Lake
Ferro Mine
Lost Frog Lake
Stuart Lake
LEGEND
I quartz eye granite
H basalt flows and breccia
G welded tuff
F andesite and basalt flows and breccia
E rhyolite
D tuff and greywacke
C andesite and basalt flows and breccia
B quartz feldspar porphyry
A biotite dacite
cross bedded arenite conglomerate
B3 sample location

Figure 1

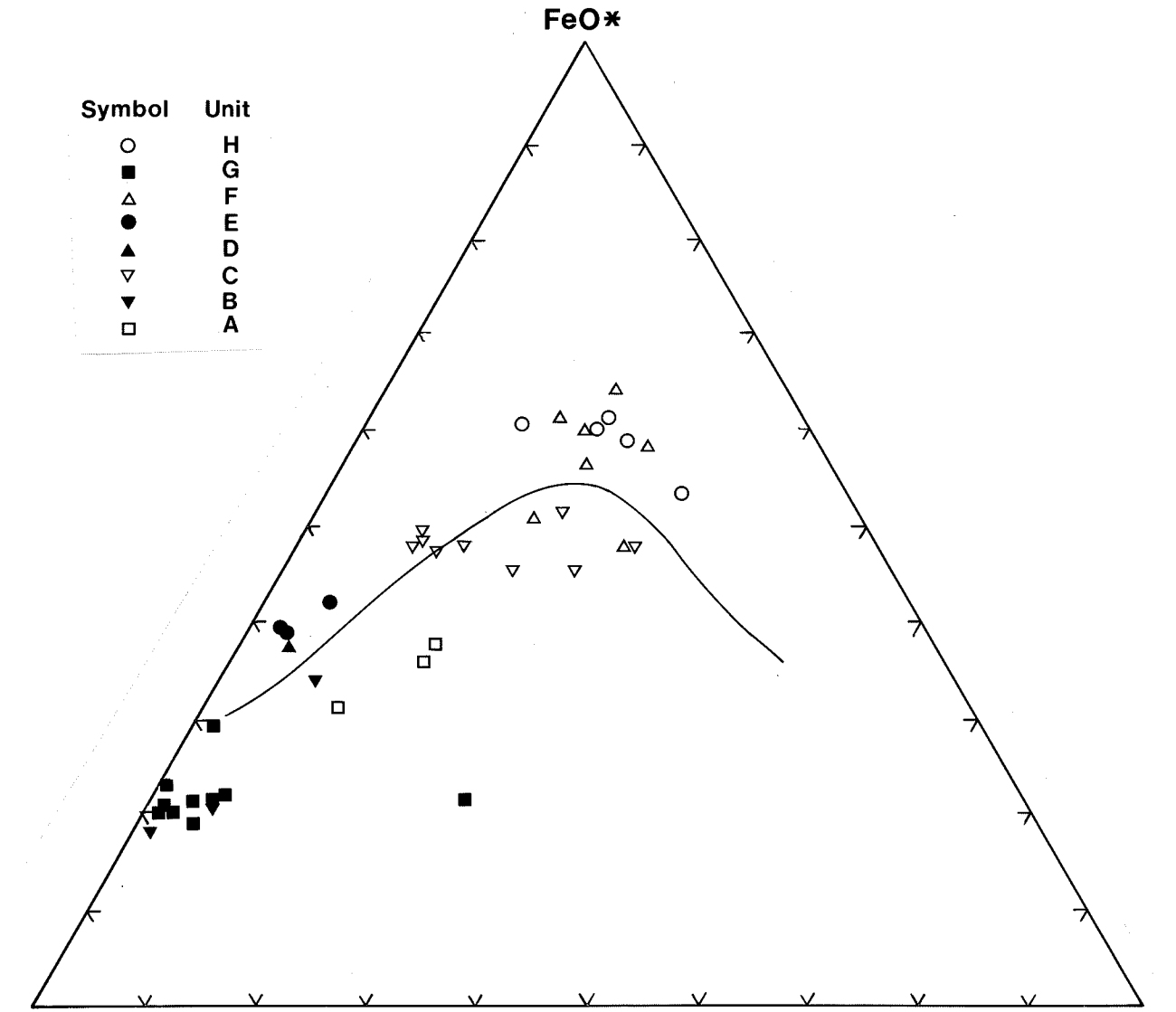

Figure 2

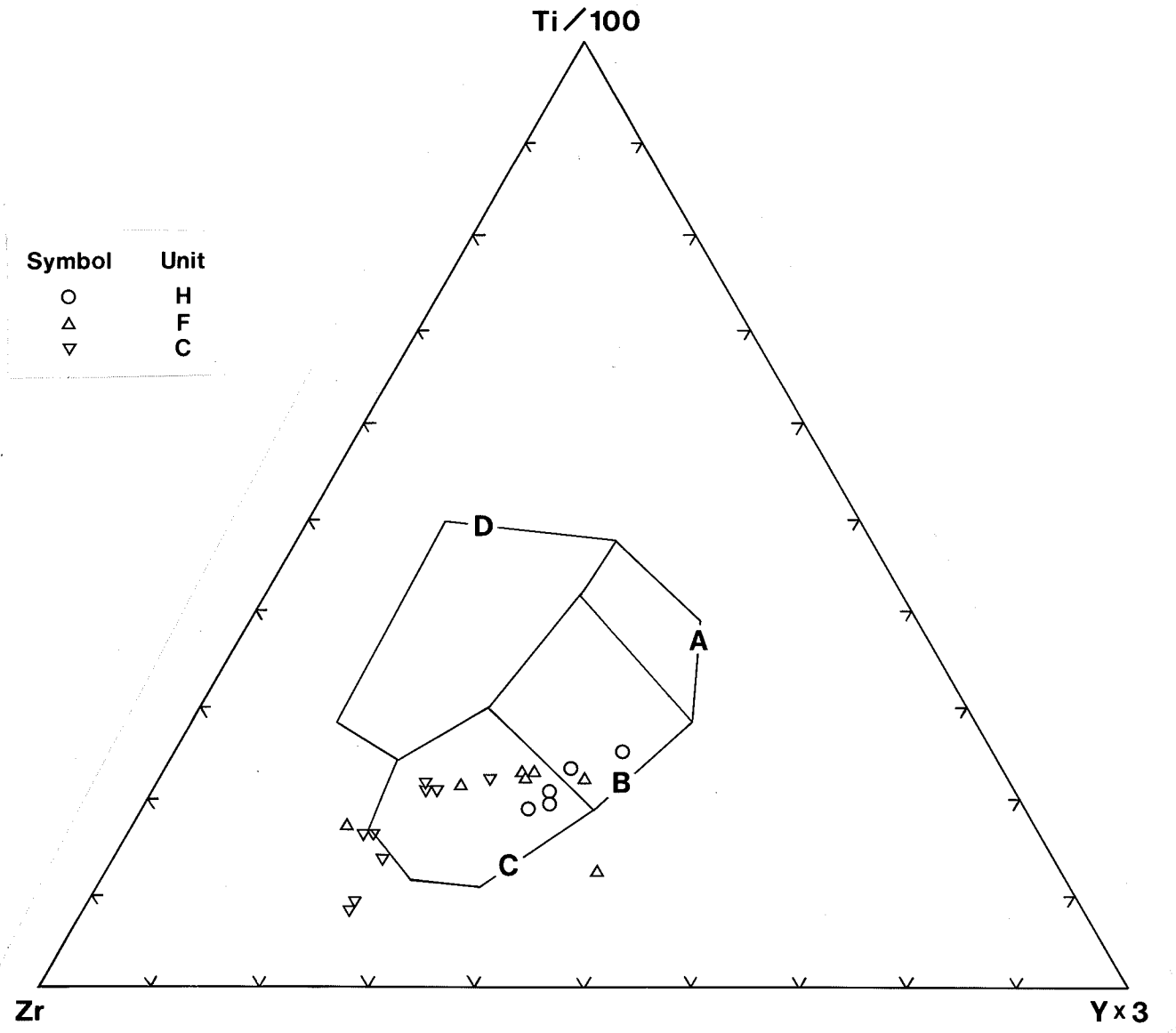

Figure 3

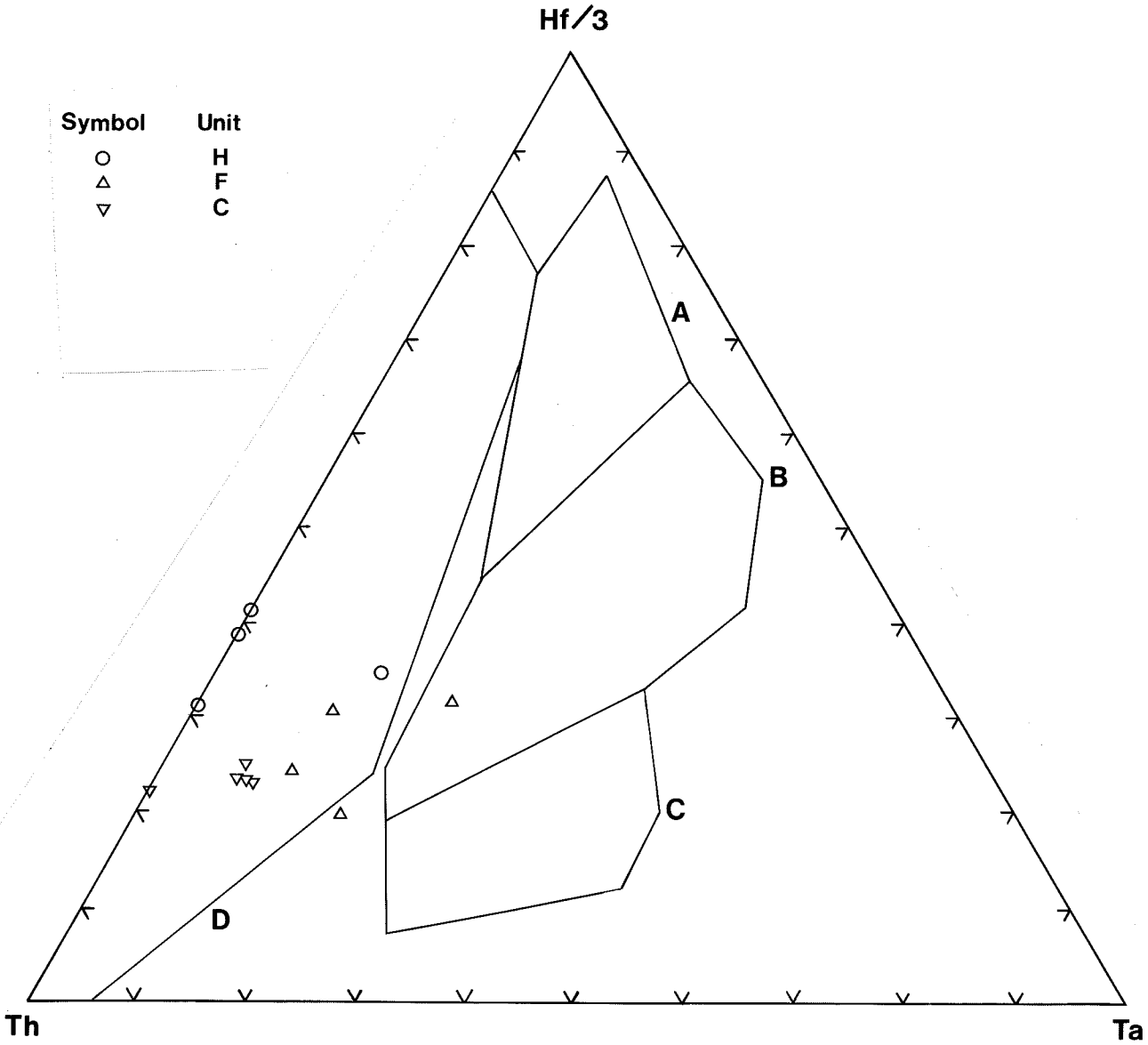

Figure 4

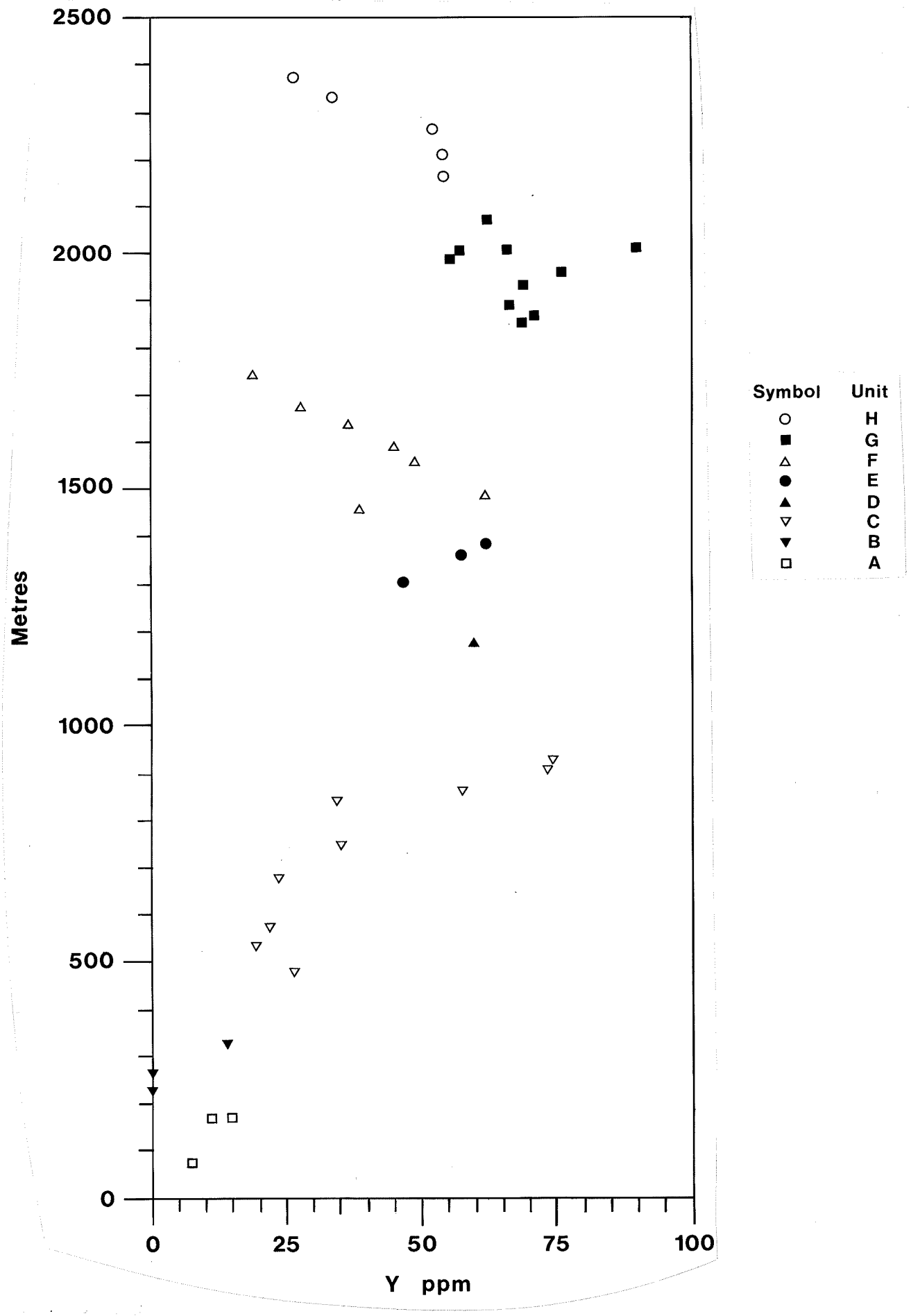
2500
2000
1500
1000
500
0
Metres
0
25
50
75
100
Y ppm
Symbol
Unit
H
G
F
E
D
C
B
A

Figure 5

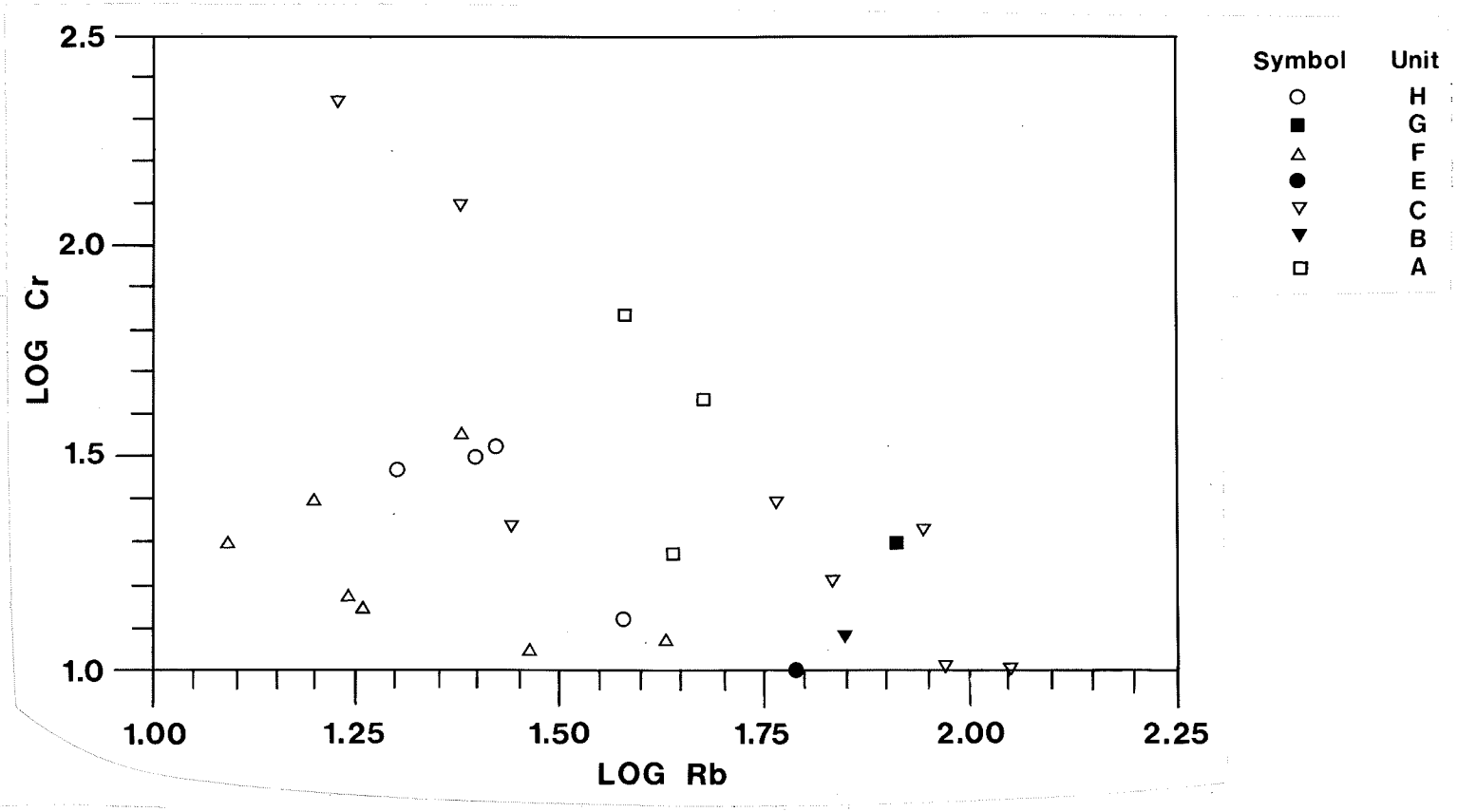
2.5
2.0
1.5
1.0
LOG Cr
1.00
1.25
1.50
1.75
2.00
2.25
LOG Rb
Symbol
Unit
H
G
F
E
C
B
A

Figure 6

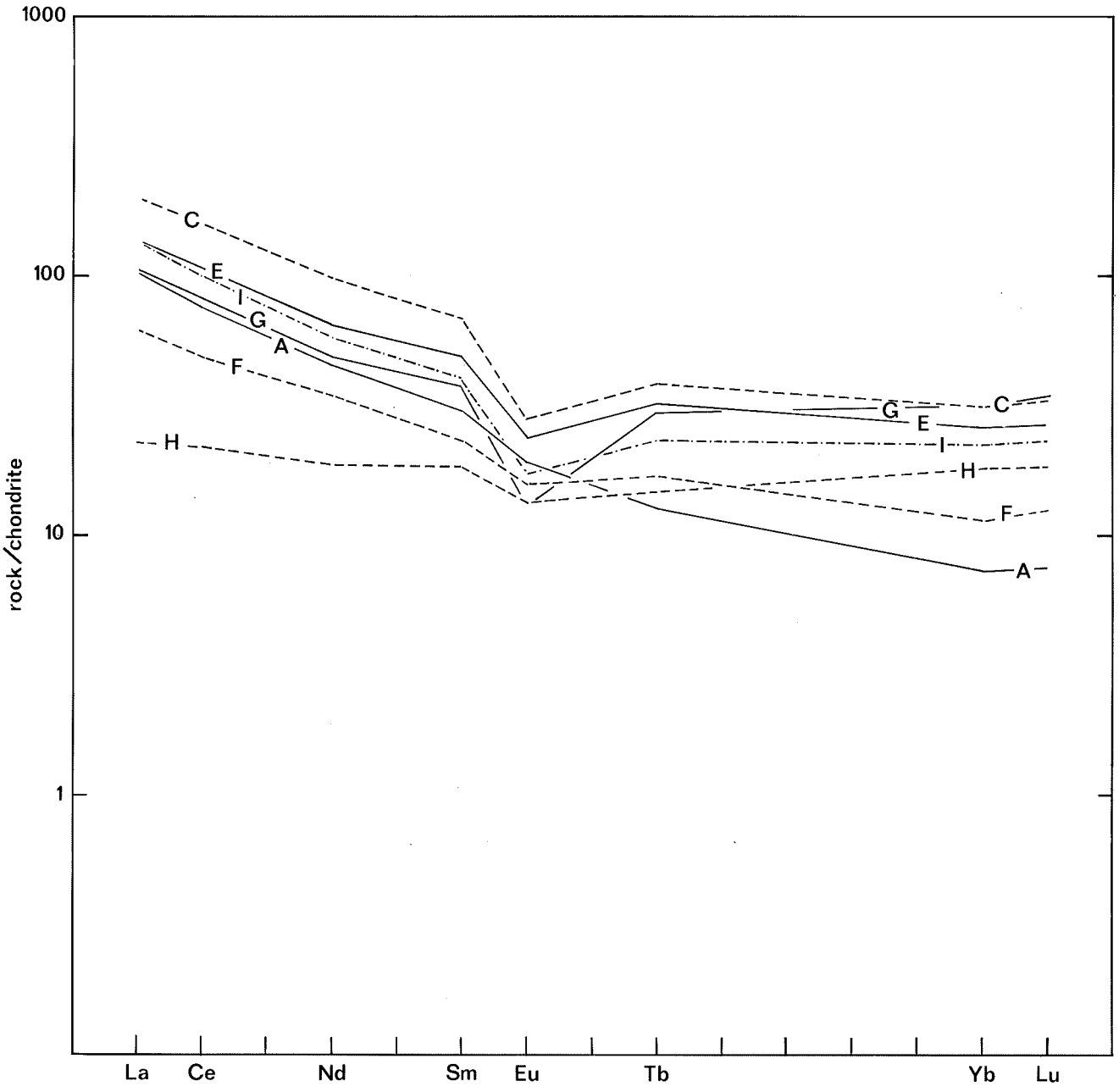

Figure 7

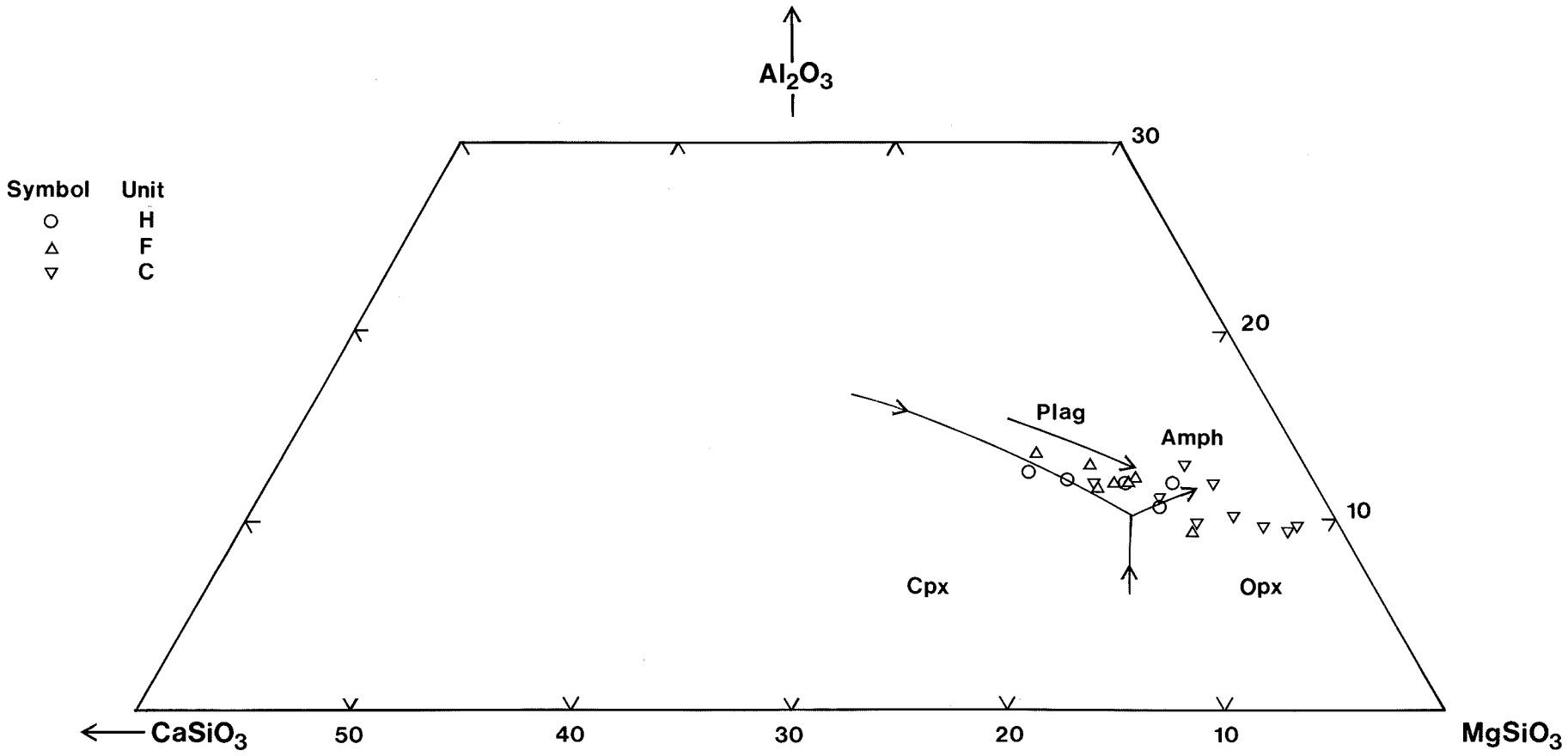
Symbol
Unit
H
F
C
Al_2O_3
30
20
10
Plag
Amph
Cpx
Opx
$CaSiO_3$
50
40
30
20
10
$MgSiO_3$

Figure 8

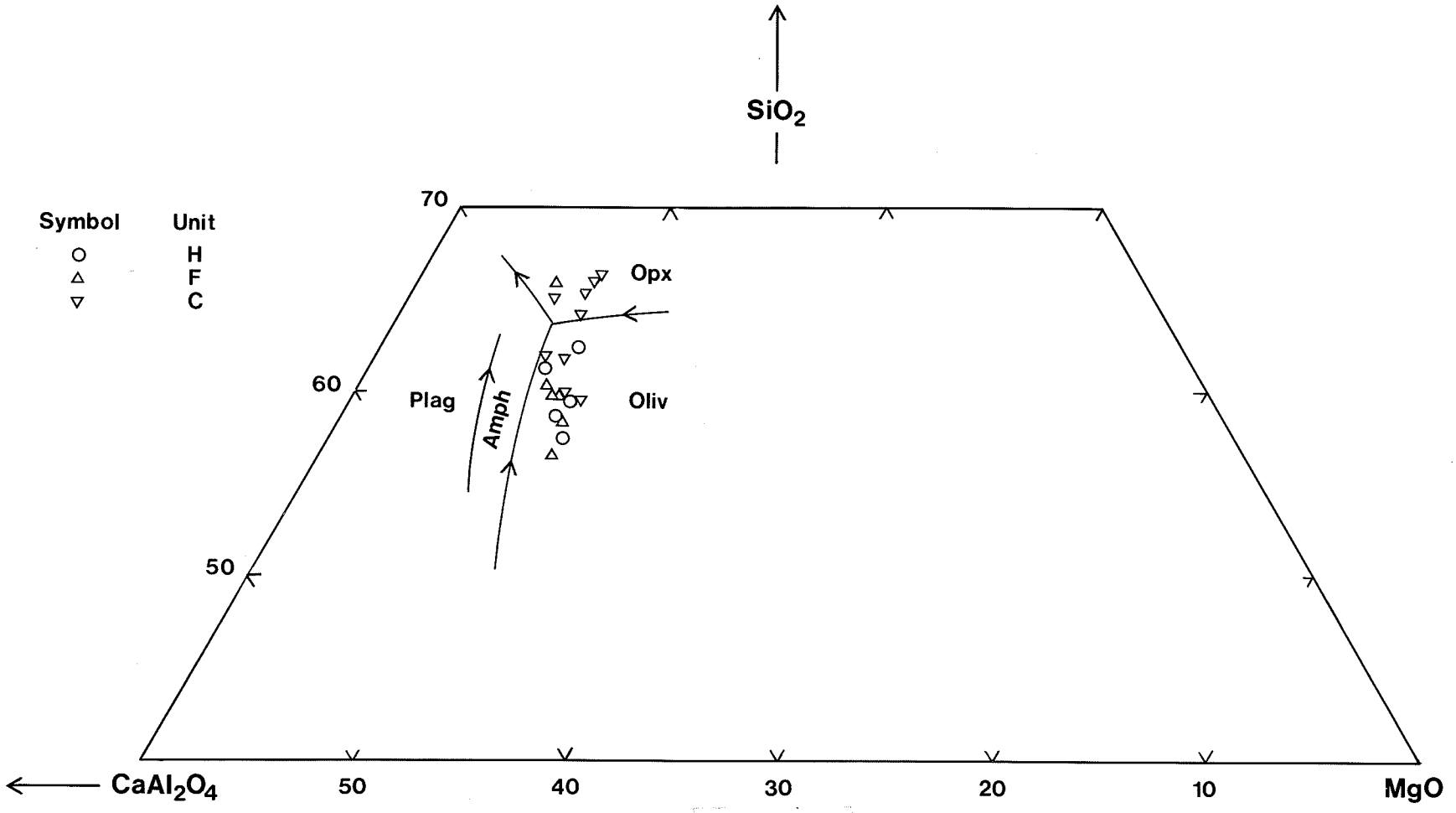
SiO2
Symbol
Unit
H
F
C
70
60
50
Opx
Plag
Amph
Oliv
CaAl2O4
50
40
30
20
10
MgO

Figure 9

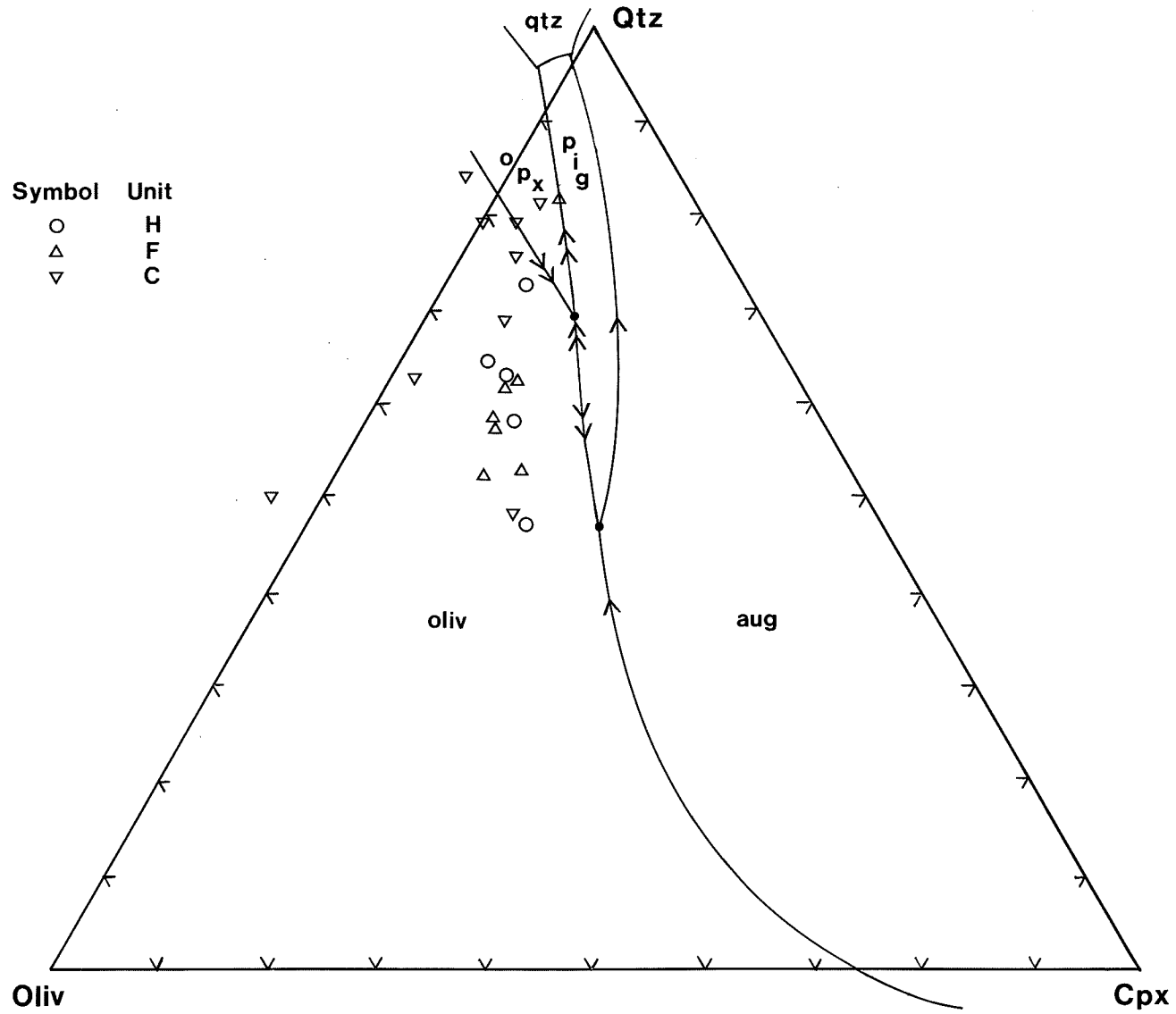

Figure 10

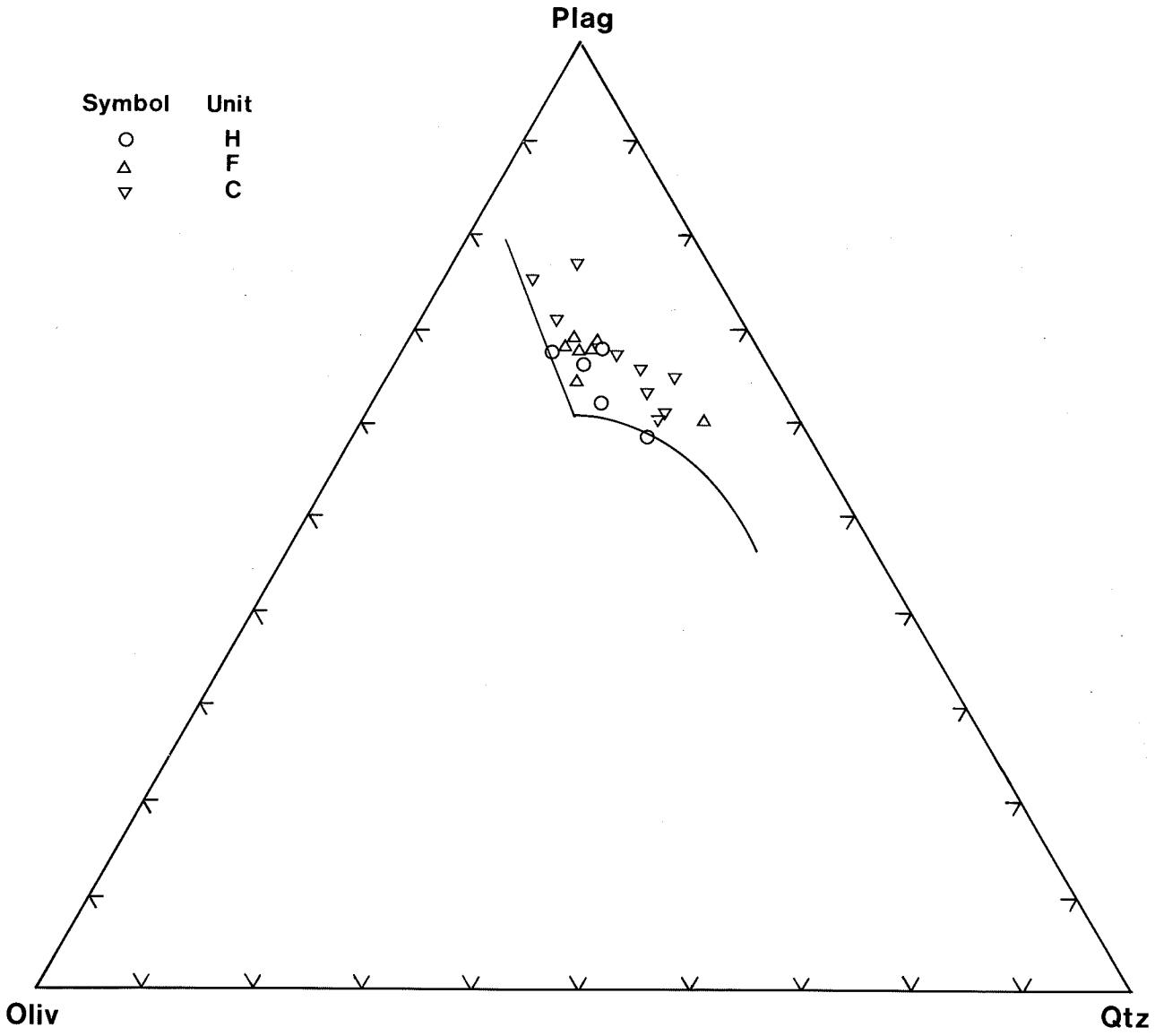

Figure 11