

ASPECTS OF THE GEOCHEMISTRY OF ONVERWACHT GROUP LAVAS
FROM THE BARBERTON GREENSTONE BELT

by

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APPENDIX I.

Brief petrographic descriptions of all the samples analysed in this work are given below, along with sample location and rock type. Samples that are not prefixed with the letters HSS, SC, SD or DC are from the Viljoens' collection and Viljoen and Viljoen (1969b,c,d,e) can be consulted for further details of these samples. The following abbreviations are used:-

KF	- Komati Formation	cpx.	- clinopyroxene
TF	- Theespruit Formation	opx.	- orthopyroxene
SF	- Sandspruit Formation	plag.	- plagioclase
HF	- Hooggenoeg Formation	cmt.	- chromite
KrF	- Kromberg Formation	mt.	- magnetite
phenos.	- phenocrysts	qtz.	- quartz
gmass.	- groundmass	serp.	- serpentine
AAM	- aligned grains of amphibole and magnetite	actin.	- actinolite
diam.	- diameter	trem.	- tremolite
ld.	- longest dimension	amph.	- amphibole
ol. ^a	- olivine	chlor.	- chlorite
		devit.	- devitrified
		poss.	- possibly

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
<u>Ultramafic Komatiites (aphyric group)</u>		
HSS-88C	KF. Flow	Aphanitic aphyric rock with spherical vesicles (0.5-3 mm diam.) lined with mt., gmass. of amph., serp. and minor mt.
HSS-88A	KF. Flow	Plate spinifex, ol. blades 20-30 mm. long and 0.3 mm. wide, interblade areas of cpx. blades (altered) and AAM.

a Note that where olivine is mentioned in the following descriptions it has usually been pseudomorphed by serpentine and magnetite, and when relict grains of olivine are preserved this will be stated.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
HSS-533	KF. Flow	Plate spinifex, ol. blades up to 50 mm. long, interblade areas of smaller ol. blades and AAM with very minor epidote and chlor.
HSS-95	KF. Flow	Plate spinifex, ol. blades 20 x 2 mm., interblade areas of aligned grains of amph. and mt. (AAM), some skeletal mt.
HSS-90	KF. Flow	Random spinifex, ol. blades up to 4 mm. long and 0.1 mm. wide, interblade areas of AAM and spherical vesicles lined with mt. (up to 0.6 mm. in diam.).
HSS-89	KF. Flow	Plate spinifex, ol. blades 20 x 0.4 mm., interblade areas of short (0.7 x 0.1 mm.) ol. blades and AAM.
HSS-531	KF. Flow	Random spinifex, ol. blades up to 20 x 0.4 mm., interblade areas of AAM often with hopper ol. and spherical, mt. lined vesicles.
HSS-532	KF. Flow	Sample from junction between random and plate spinifex textured ols. in Stuarts flow. See HSS-531 and HSS-533 descriptions for additional information.
HSS-530	KF. Flow	Aphanitic aphyric rock occasional micro-phenos. of ol. (both skeletal and solid), gnass. of amph., mt. and serp. with small patches of ol. blades. Skeletal ol. 0.6 x 0.3 mm., solid ol. phenos. 0.1-0.2 mm. across.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
HSS-523	KF. Pillow	Aphanitic aphyric rock, very fine grained serp., amph. and mt.
AU-5	KF. Pillow	Aphanitic aphyric rock, occasional micro-phenos. of ol. (0.2 to 0.3 mm.) gmass. of ol., amph., mt., chlor. and very minor epidote.
HSS-87	KF. Flow ?	Aphanitic with microphenos. of ol. (0.4 - 0.6 mm. in ld.), gmass. of amph., serp. and mt.
HSS-14	KF. Flow ?	Aphanitic aphyric rock with minor small ol. (0.3 mm across), some relict cores preserved, gmass. of amph., minor serp. and mt.
HSS-15	KF. Fragmented pillow ?	Aphanitic aphyric rock small ol. crystals up to 0.4 mm. long, gmass. of amph., serp., mt. and chlor.
53-J	KF. Dyke	Holocrystalline rock consisting of ol. (0.7 x 0.4 mm.) and large irregularly shaped cpx. partly altered to amph.
49-J	KF. Flow	See Green et al. (1975).
HSS-109	SF. Flow	Plate spinifex, poorly preserved, long serp. blades (100 mm. or more) lined with sheaths of mt., abundant large crystals of chlor. and minor calcite.
HSS-150	TF. Flow ?	Aphanitic aphyric rock consisting of serp., amph., mt. and chlor. with very minor calcite.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
<u>Olivine Phyric Ultramafic Komatiites</u> (porphyritic group)		
HSS-88B	KF. Flow	Aphanitic rock with abundant ol. (0.6-0.8 mm. in ld.); gmass. of amph., mt. and very minor epidote.
HSS-535	KF. Flow	Medium to fine grained rock consisting of closely packed equant ol. (0.5-0.7 mm. across), abundant relict cores; gmass. of amph., minor chlor. and serp.
HSS-534	KF. Flow	As above except no relict ol. cores.
HSS-536	KF. Flow	Fine grained rock, abundant ol. in matrix of amph., chlor. and serp.
VU-25	KF. Flow	Fine grained ol. phyric rock, closely packed equant ol. (0.5 mm. across); gmass. of serp. and mt.
HSS-93	KF. Ultramafic horizon	Fine grained ol. phyric rock (ol. 0.4-0.8 mm. in ld.); gmass. of amph. and minor octahedra of mt.
V-2	KF. Flow	Fine grained ol. phyric rock (ol. 0.2-0.7 mm. in ld.); gmass. of amph. and chlor.
VU-30A	KF. Flow or sill	Medium to fine grained ol. phyric rock, ol. rounded, up to 0.8 mm. across with relict cores; gmass. of amph.
HSS-8	KF. Flow	Fine grained ol. phyric rock, ol. 0.5 mm. across with minor relict ol. cores; gmass. of amph.
HSS-13	KF. Flow ?	Medium to fine grained ol. phyric rock, ol. (up to 1 mm. in ld.) well preserved as relict cores, minor interstitial cpx. altered to amph.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
VU-32A	KF. Flow	Medium to fine grained ol. phyric rock, ol. as tabular (1 x 0.5 mm.) and smaller (0.5 mm. across) rounded grains, abundant relict ol. cores preserved. Gmass. of amph. and minor cmt. microphenos.
<u>Olivine Rich Ultramafic Komatiites</u> (porphyritic group)		
R-13	KF.	Medium grained ol. rich rock, ol. grains (2 x 0.7 mm.) in gmass. of serp. and mt., abundant calcite and minor amph.
R-16	KF.	Medium grained ol. rich rock, (ol. up to 2 mm. in ld.), sample is entirely serp. and mt. with very minor calcite.
20-J	HF.	Medium grained ol. rich rock, ol. as 1-3 mm. long, isolated euhedral grains. Rock consists totally of serp. and minor mt.
<u>Olivine-Clinopyroxene Phyric Ultramafic Komatiites</u> (porphyritic group)		
HSS-92	KF. Dyke ?	Medium grained holocrystalline rock, consisting of 25% rounded ol. (1.2 mm. across) grains included in large irregularly shaped fresh cpx. crystals.
HSS-27	KF. Sill or Flow	Medium to fine grained holocrystalline rock, consisting of ~70% rounded ol. (0.5-0.7 mm. across) occasionally rimed with opx. all included in large cpx. grains. Minor mt. octahedra also included in cpx. Very minor amph. and biotite.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
HSS-31	KF. Sill ?	Medium grained holocrystalline rock, consisting of rounded ol. (up to 1.5 x 1 mm.) grains in large cpx. grains. Minor mt. inclusions in cpx.
HSS-33	KF. Ultramafic horizon	Fine grained holocrystalline rock, consisting of rounded ol. (~80%, 0.6 x 0.3 mm.) included in large cpx. grains (well preserved).
HSS-1	KF. Sill ?	Fine grained holocrystalline rock, ol. rounded (0.3-0.4 mm. across) as inclusions in large cpx. grains.
HSS-28	KF. Ultramafic horizon	Similar to HSS-1 with mt. and cmt. microphenos. in the cpx.
52-J	KF. Dyke	Medium to fine grained holocrystalline rock, consisting of rounded ol. (up to 1 mm. across) grains included in large irregularly shaped cpx. grains. Cpx. altered to amph. and minor chlor.
<u>Pyroxenite</u>		
SD-76	KF. Stolzberg Ultramafic Body	Medium to coarse grained orthopyroxenite, opx. (1-4 mm. in ld.) very fresh with only minor alteration to talc on grain margins. Minor euhedral chromite grains occur in the opx.
<u>Sandspruit Formation Ultramafic Komatiites (texturally altered group)</u>		
87-J	SF.	Holocrystalline, metamorphic texture, mainly actin. (~70%), large chlor. plates and mt. with very minor epidote.
88-J	SF.	Similar to 87-J with minor serp.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
VU-33	SF.	Holocrystalline, serp., talc chlor., mt. and amph. with very minor epidote.
HSS-131	SF.	Similar to VU-33.
HSS-130	SF.	Similar to VU-33 with minor calcite.
HSS-105	SF.	Similar to VU-33 except with very minor amph.
HSS-107	SF.	Similar to VU-33.
HSS-112	SF.	Similar to VU-33.
86-J	SF.	Holocrystalline rock consisting of serp., minor chlor. and mt. with very minor calcite, no igneous texture preserved.
<u>Aphyric High-Mg Mafic Komatiites</u>		
42-J	KF.	Micro-spinifex consisting of pyroxene blades, devit. glass, equant cpx. crystals (altered to amph. and talc), minor spinel and plag.
HSS-62	KF. Pillow	Micro-spinifex of pyroxene, altered to trem.-actin., patches of chlor. common, very minor epidote.
K-178	Kaapmuiden- Malelane area	Aphanitic rock, gmass. of amph., minor chlor. and opaques.
SG-80	Steynsdorp Valley	Similar to K-178.
KJ-39	Kaapmuiden- Malelane area	Aphyric rock with long trem.-actin. needles in gmass. of trem.-actin., minor chlor. and talc.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
<u>Porphyritic High-Mg Mafic Komatiites</u>		
HSS-12	KF. Flow	Fine grained altered (serp.) phenos. in mass. of amph., chlor. and minor epidote and opaques. Phenos. either altered opx. or ol. Minor opaques included in altered phenos.
HSS-9	KF. Flow	Fine grained, abundant pyroxene phenos. altered to amph., chlor. and serp. Gmass. of amph., chlor., serp. and minor sphene. Minor spinel often as inclusions in pyroxene.
HSS-10	KF. Flow	Fine grained with abundant euhedral pyroxene phenos., altered to amph., often with small serpentized inclusions. Gmass. of serp., amph., chlor. and sphene, and minor rods of mt.
HSS-54	KF.	Fine-medium grained, pyroxene altered to amph., minor serp., possibly originally ol. Minor chlor., opaque calcite and sphene.
<u>Aphyric Low-Mg Mafic Komatiites</u>		
SD-82 - SD-85 SC-2 - SC-13	KF. Pillows	Detailed description given in Chapter 2.
TS-1	TF. Steynsdorp Anticline.	Aphanitic aphyric rock of amph., minor qtz., plag., calcite and epidote.
HSS-73	KF. Flow	Aphanitic aphyric rock with laths of amph. (0.1 mm. ld.), minor altered plag. and calcite.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
HSS-21	KF. Flow	Aphanitic with ocelli, cpx. (partly altered to amph.) and plag. (altered) microphenos. (0.1 mm. ld.). Minor spinel octahedra throughout.
HSS-91	KF. Pillow	Aphanitic with very minor altered plag. phenos. (0.6 mm.). Devit. glass and glomeroporphyritic spinel octahedra.
HSS-25	KF. Flow	Aphanitic aphyric with minor small cpx. and plag. crystals in devit. glass. Minor calcite.
SD-42C	KF. Flow ?	Long actin. blades (20 mm. long), poss. altered cpx. spinifex, gmass of fine grained plag., pyroxene, qtz., actin. and very minor epidote, spinel, calcite and sphene.
HSS-65	KF. Flow	Aphanitic with minor cpx. and plag., cpx. as blades up to 1.5 mm. long. Gmass. of cpx., plag., devit. glass and very minor calcite.
HSS-82	KF. Pillow	Aphanitic with minor content of cpx. and plag. (altered to qtz. and calcite), phenos. (<0.1 mm. in ld.). Gmass. of amphibole needles, chlor. and very minor epidote, spinel, calcite and sphene.
HSS-84	KF. Pillow	Similar to HSS-82 but no spinel.
SC-6B	KF. Flow	Aphanitic rock with cpx. (altered to amph.), 0.1 mm. long with fine grained amph., qtz, sphene and very minor epidote.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
HSS-81	KF. Pillow	Similar to HSS-82.
HSS-154	TF. Flow	Aphanitic aphyric rock of actin., minor sphene, epidote and qtz.
HSS-70	KF. Pillow ?	Aphanitic consisting of fibrous amph. partly replaced by chlor. Glomeroporphyritic spinel throughout. Minor epidote, qtz. and sphene.
HSS-7	KF. Flow	Aphanitic aphyric rock with laths of amph., also with qtz., albite, sphene and very minor chlor., epidote and calcite.
HSS-C1	KF. Flow	Aphanitic with minor cpx., phenos (altered to amph.). Gmass. of amph., minor spinel and very minor epidote.
SC-6A	KF. Flow Top Breccia	Aphanitic with amph. needles up to 1 mm. long. Gmass. of actin., chlor., opaques and very minor epidote.
HSS-C3	KF. Basal Chilled Margin	Aphanitic with amph., chlor., qtz., spinel, very minor epidote and occasional altered microphenocrysts of ol.
<u>Porphyritic Low-Mg Mafic Komatiites</u>		
HSS-16	KF. Flow	Holocrystalline consisting of cpx. (altered to amph.), plag., skeletal ilmenite and spinel. Cpx.(0.6 - 1 mm. long) with interstitial plag. (up to 4 mm. long), minor brown hornblende.
HSS-517	TF.	As for HSS-16 but no hornblende.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
SC-12	KF. Flow	Holocrystalline, cpx. and plag., plag. up to 1.5 mm. long, cpx. 0.5 mm. in ld., both minerals altered.
HSS-64	KF. Flow	Aphanitic with ~50% cpx. (0.2 mm.) and 50% gmass. of amph., qtz. and plag., very minor spinel and sphene. Cpx. altered to actinolite.
AB-9	KF.	Similar to HSS-64, cpx. well preserved.
HSS-20	KF. Flow	Similar to HSS-64, with well preserved cpx.
HSS-34	KF. Flow	Holocrystalline with cpx. and interstitial plag., cpx as euhedral grains or needles. Minor sphene epidote and chlor.
526	KrF.	Holocrystalline coarse grained with cpx., plag. and matrix: Cpx. ~50% (up to 3 mm. in ld.) well preserved. Plag., qtz., amph., chlor. and minor epidote in matrix.
KJ-55	Kaapmuiden- Malelane area	Similar to HSS-64 but poorly preserved igneous texture.
HSS-157	TF. Flow	Hypocrystalline, cpx. (amph.) ~50%, gmass. of amph., chlor., qtz., sphene and very minor epidote.
LV-6	HF.	Coarse grained plag. and cpx., cpx well preserved, plag. altered, minor spinel.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
M-57	KrF.	Holocrystalline, cpx. > plag., cpx. well preserved, plag. altered, minor opaque material.
HSS-6	KF. Flow	Similar to M-57, but cpx. altered to amph. and minor talc, calcite and epidote.
HSS-32	KF.	Similar to HSS-16 except no hornblende.
R-14	KF.	Holocrystalline, >70% cpx., fresh or partly altered to amph., minor qtz. and very minor chlor., epidote, sphene and calcite.
HSS-C2	KF. Flow	Aphanitic with abundant cpx., phenos. (altered to amph.), minor qtz., gmass. of amph., spinel and trace of epidote.
SD-42A	KF. Flow	Hypocrystalline ~50% euhedral cpx. (altered to amph.), gmass. of amph., chlor., qtz. and very minor epidote and sphene.
HSS-77	KF.	Similar to HSS-16.
HSS-78	KF. Flow	Hypocrystalline with cpx. (altered to actin. and chlor.), gmass. of chlor., amph., qtz. and minor epidote and sphene.
VB-2	KF. Flow	Holocrystalline, predominantly cpx. (altered to amph.), gmass. of qtz., plag. and amph.
HSS-51	KF.	Similar to HSS-16 with more cpx.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
HSS-332	KrF. Massive	Hypocrystalline, abundant euhedral cpx., some fresh or altered to amph. and chlor. Gmass. of devit.glass (chlor., amph.), very minor epidote and spinel.
SC-6C	KF. Flow	Hypocrystalline with abundant cpx., phenos. (altered) in gmass. of amph., chlor., minor epidote and sphene. Minor serp. in places.
<u>Texturally Altered Mafic Komatiites</u>		
HSS-96	Helshoogte Pass Pillow	Holocrystalline, actin., minor qtz., plag. and sphene, ocelli, altered plag. and actin.
HSS-108	SF. Flow ?	Holocrystalline, interlocking grains actin. (~60%) and plag. (~40%), very minor sphene and pyroxene.
HSS-117	SF. Flow ?	Similar to HSS-108.
AB-21	TF.	Holocrystalline, actin. in fine grained matrix, actin. qtz., minor plag. and very minor epidote.
HSS-38	Helshoogte Pass	Similar to HSS-108.
HSS-118	SF. Flow ?	Holocrystalline, actin with minor interstitial chlor., sphene and epidote.
HSS-122	SF. Flow ?	Similar to HSS-118.
HSS-148	TF.	Long laths of actin. with minor qtz. and epidote.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
KJ-40	Kaapmuiden- Malelane area	Fine grained, angular amph. grains with interstitial chlor., amph., qtz. and minor epidote.
SG-3	Steynsdorp Valley	Fine grained actin. and minor opaques.
<u>Low-Ti Basalts</u>		
34-J	HF. Pillow	Aphanitic aphyric rock, laths of amph., minor qtz., epidote, plag. and sphene. Several epidote rich veins.
V-16	HF. Pillow	Similar to 34-J but without epidote veins.
40-J	HF. Massive	Aphanitic aphyric rock with abundant laths of cpx. (altered to amph.), minor plag., epidote, chlor. and sphene.
LV-7	HF. Massive	Aphyric fine grained rock with matrix of altered cpx. and plag., minor sphene, spinel and epidote.
V-36	HF. Massive	Aphanitic with abundant cpx. (altered to amph. and chlor.), minor plag., epidote, sphene and spinel.
M-390	HF. Massive	Aphyric fine grained rock, cpx. crystals (0.1 mm. ld.) partially altered to amph. Gmass. of plag., chlor. and opaques.
HSS-518	TF. Massive	Fine grained, ~30 cpx., altered to amph., abundant needles (0.4 mm. ld.) of qtz., minor epidote and spinel.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
HSS-56	KF. Flow	Cpx. phyric, with well preserved cpx. (up to 2 mm. ld.). Plag., amph., qtz., sphene and spinel, chlor. in gmass.
HSS-58	KF. Flow	Similar to HSS-56 except cpx. crystals smaller (up to 1 mm. ld.).
HSS-43	KF. Massive	Holocrystalline, cpx. (up to 3 mm. ld.) and interstitial plag. (altered to albite and epidote), cpx. altered to amph., amph. and minor spinel in gmass.
LV-4	HF. Massive	Cpx. phyric (cpx. 0.4 mm.), gmass. of chlor., plag., qtz., amph. and epidote, minor spinel.
<u>High-Ti Basalts</u>		
LV-9	KrF. Massive to Pillowed	Aphanitic aphyric, abundant plag. laths (0.2 - 0.3 mm. ld.) with cpx. (altered to amph.), chlor. and epidote.
21-J	KrF. Pillow	Aphanitic with abundant altered cpx. and plag. and quenched ilmenite. Matrix of amph., qtz. and epidote.
SC-9	KF. Massive	Similar to 21-J.
HSS-224	HF. Pillow	Aphyric with altered gmass. (probably chlor. and amph.). Abundant light coloured ocelli. Vesicles filled with qtz., calcite, epidote and chlor.

<u>Sample No.</u>	<u>Location and Type</u>	<u>Description</u>
<u>High-Mg Basalts</u>		
HSS-2	KF. Flow	Holocrystalline with abundant cpx. (0.2 - 0.3 mm.), minor plag. and qtz., matrix of amph., chlor., qtz., plag., epidote and minor calcite.
HSS-23	KF. Flow ?	Holocrystalline with plag. > cpx., minor sphene and spinel. Plag. altered to albite, chlor. and epidote, cpx. altered to amph. and chlor., minor calcite.
HSS-35	KF. Massive	Holocrystalline, plag. (3 - 4 mm.) and pyroxene (up to 1 mm.), plag. altered, minor spinel, chlor., calcite and epidote.
<u>Altered Basalts and Other Lava Types</u>		
V-13	HF. Pillow	No thin section.
DC-1	HF. Pillow	Aphanitic with minor cpx., devit. glass altered to chlor. Ocelli replaced by carbonate.
HSS-39	KF. Helshoogte Pass	Metamorphic texture, interlocking grains of plag., actin. and opaque, minor epidote.
HSS-83	KF. Flow	Fine grained rock with needles of actin., abundant patches of qtz. (0.5 mm. diam.), epidote, qtz. and plag. in matrix.
HSS-111	SF.	Fine grained rock of plag. and actin., plag. altered, minor epidote.
HSS-52B	KF. Pillow	Aphanitic aphyric rock, minor carbonate.

APPENDIX II.

SAMPLING METHODS

Large 1 - 3 kg. samples were taken in the field of rocks sampled by the author for this project. In the laboratory weathered surfaces were removed and the samples reduced to chips using a rock splitter and jaw crusher (carbon steel jaws). Two hundred - five hundred gms. of material was then reduced to -120# powder, using either an agate vessel on a swing mill grinder, or a carbon steel vessel and Fe-Mn-Si balls in a ball grinder. Six gms. of the -120# material was ground to -300# in an automatic agate pestle and mortar. Five gms. of this material was pressed into a briquette (Baird, 1961) and used for the analysis of Na_2O and trace elements by X-ray fluorescence (XRF). The remaining -300# material was used in the preparation of Li-tetraborate fusion discs (Norrish and Hutton, 1969) for major element analysis and in the determination of H_2O^+ and CO_2 by gas chromatography. Special sampling procedures were adopted for the pillow samples that were used in the alteration study (see Chapter 2) as outlined below:-

Margin samples were obtained from five of the ten pillows sampled by chipping off 200 - 300 gms. of material from the outer ~2 cm. thick chilled rim. Large samples (2 - 3 kg.) were taken from the cores of the pillows in order to circumvent any problems that may have been caused by the inhomogeneous distribution of ocelli. These ocelli, which have been described by Viljoen and Viljoen (1969c) and Ferguson and Currie (1972), were present in all the pillow core-samples discussed in Chapter 2, but not in the intermediate (between margin and core) sample SC-3I. The samples were prepared for analysis using the procedures described above.

Ocelli up to 1 cm. in diameter were cut from 2 mm. thick slabs of the SC-13 core sample, using a Notcher saw with a diamond impregnated wire blade, and reduced to -120# powder, using a carbon steel pestle and mortar. The

ocelli sample was prepared for analysis as described above. Four gm. aliquots of -300 powder from two margin-core pillow pairs (SC-2 and SC-5) were leached with cold 3M HCl for three hours, washed with distilled water, dried and prepared for analysis. The results of this leaching experiment are discussed in Chapter 2.

ANALYTICAL METHODS

ELECTRON MICROPROBE

Mineral grains were analysed on polished thin sections using a Cambridge Microscan 5 electron microprobe. The major elements were determined using the methods and instrumental conditions given in Le Roex and Reid (1978). Ni was determined in the olivine and pyroxene grains using the instrumental conditions given in Moore and Erlank (1979).

X-RAY FLUORESCENCE

The bulk rock samples were analysed for 25 major and trace elements by XRF using the methods given in Willis et al. (1971, 1972). It should be noted that in order to avoid the effects of possible mineralogical problems on the Cr data, all the Cr data reported for the komatiite lavas (where Cr is usually present at concentrations >600 ppm) were obtained from the Li-Tetraborate discs. The estimated precisions of the analyses based on counting statistics (4 standard deviations) for typical major and trace element concentrations encountered in komatiitic lavas, are given in Table 2-4. FeO was determined by standard wet chemical methods.

In order to ensure consistency between the olivine Ni data, obtained by electron microprobe, and the ultramafic komatiite Ni data,

obtained by XRF, an olivine megacryst (LBM-39B) was analysed by both methods. The XRF data for the Onverwacht Group lavas and LBM-39B were obtained using the international standards (W-1, NIM-N, NIM-D and PCC-1, Ni values given in Abbey, 1975) and three carefully prepared synthetic standards ranging in Ni concentration from 1000 to 3000 ppm Ni. The value obtained for LBM-39B under these conditions was 2943 ± 40 ppm Ni (two standard deviations, calculated from six separate determinations) and is essentially identical to that obtained from the electron microprobe (R. Rickard, 1976, pers. comm.) using a synthetic glass standard (Ni_2SiO_4) prepared in 1970 by J. Ito at the Geophysical Laboratory (Washington).

GAS CHROMATOGRAPHY

H_2O^+ and CO_2 were determined by gas chromatography using a Hewlett Packard 185B CHN Analyser (oxidation furnace temperature of 1050°C), and 50s combustion time, a 3380A Integrator and 30 - 40 mg. of sample powder (-300#) pre-dried at 110°C and accurately weighed on a Cahn 4400 Electrobalance to four decimal places. The following international standards were used for the H_2O^+ calibration; PCC-1, T-1, AGV-1, BCR-1, DTS-1, NIM-L, NIM-G, NIM-N, NIM-D, NIM-P and NIM-S assuming the concentrations given in Abbey (1975). The CO_2 calibration was achieved using the above NIM standards (with the CO_2 values given in Abbey, 1975) and synthetic CaCO_3 -quartz mixes. Two metamorphosed lavas, HSS-64, a mafic komatiite consisting mainly of actinolite-tremolite and HSS-112, an ultramafic komatiite consisting mainly of serpentine and chlorite, were analysed repeatedly to obtain some idea of the precision of the method. These data are tabulated below:-

<u>Sample</u>	<u>(n)</u>	<u>H₂O⁺</u>	<u>s.d.</u>	<u>c.o.v.</u>	<u>CO₂</u>	<u>s.d.</u>	<u>c.o.v.</u>
HSS -64	(8)	2.82%	0.03%	1.1%	1.10%	0.02%	1.8%
HSS-112	(8)	9.54%	0.12%	1.3%	2.87%	0.02%	0.7%

While the precision of the method is considered satisfactory, it should be noted that erratic results do occur, especially in samples that have not been ground to -300#, and that some mineral assemblages, particularly talc rich samples, do not break down completely during the combustion period.

Table 2-1. Major Element and Normative data for the Pillow Samples.

	SC-2		SD-82	SD-83	SD-84	SD-85	SC-8		SC-3		SC-13		SC-5		SC-11		
	Margin	Core	Core	Core	Core	Core	Margin	Core	Margin	Inter. Core	Core	Ocelli	Margin	Core	Margin	Core	
SiO ₂	49.50	51.26	52.14	50.72	51.40	52.27	52.43	52.06	52.55	53.01	52.37	53.71	60.36	52.65	52.62	53.23	53.98
TiO ₂	0.711	0.732	0.752	0.735	0.722	0.743	0.770	0.755	0.759	0.777	0.768	0.758	0.630	0.768	0.791	0.759	0.758
Al ₂ O ₃	10.38	10.88	10.97	10.73	10.67	10.91	11.23	11.13	10.64	11.37	11.84	11.07	11.01	11.63	11.65	11.65	11.61
Fe ₂ O ₃	2.86	2.21	2.22	2.57	2.47	1.93	1.55	1.51	1.67	1.51	1.67	1.69	7.86 ^a	1.81	1.72	1.67	1.72
FeO	9.02	8.32	8.51	8.74	8.45	8.56	9.54	9.06	9.66	9.35	8.90	9.09	-	9.50	9.39	8.77	8.10
MnO	0.205	0.167	0.174	0.187	0.173	0.169	0.184	0.184	0.216	0.180	0.165	0.158	0.119	0.183	0.166	0.179	0.169
MgO	10.11	9.79	9.10	9.90	9.65	9.25	8.69	9.52	8.95	9.37	9.18	9.26	6.47	9.31	8.87	8.76	8.36
CaO	12.64	10.38	10.21	11.83	11.36	10.14	10.64	10.76	11.00	9.84	9.83	9.54	8.83	9.67	10.18	10.35	11.08
Na ₂ O	1.23	2.17	2.90	1.70	1.93	2.73	2.44	2.10	2.36	2.73	2.59	2.69	3.52	2.68	2.56	2.96	3.02
K ₂ O	0.414	0.369	0.097	0.121	0.239	0.252	0.209	0.499	0.217	0.218	0.243	0.273	0.144	0.294	0.280	0.117	0.115
P ₂ O ₅	0.096	0.094	0.105	0.108	0.102	0.098	0.098	0.099	0.099	0.097	0.101	0.101	0.080	0.099	0.105	0.100	0.099
H ₂ O ⁺	3.08	2.84	2.54	2.64	2.80	2.43	1.76	2.28	2.42	1.65	1.81	2.11	0.52 ^b	1.91	1.89	2.00	1.51
H ₂ O ⁻	0.03	0.03	0.05	0.04	0.04	0.04	0.04	0.07	0.05	0.05	0.04	0.05	0.00	0.06	0.04	0.04	0.05
CO ₂	0.40	0.45	0.21	0.22	0.44	0.25	0.21	0.24	0.39	0.26	0.22	0.18	-	0.18	0.15	0.30	0.30
Total	100.47	99.75	99.97	100.14	100.45	99.77	99.79	99.82	100.98	100.41	99.73	100.68	99.54	100.74	100.41	100.89	100.87
<u>C.I.P.W. NORMS^c</u>																	
Qz	0.53	1.43	0.68	2.01	2.21	1.13	2.60	1.90	2.43	1.60	1.80	3.11	14.41	1.09	1.99	1.48	2.20
Or	2.54	2.25	0.59	0.71	1.48	1.54	1.24	3.01	1.30	1.30	1.48	1.65	0.89	1.77	1.65	0.71	0.71
Ab	10.75	19.04	25.22	14.81	16.75	23.78	21.07	18.19	20.31	23.44	22.42	23.10	30.04	22.93	22.00	25.39	25.81
An	22.17	19.56	17.11	21.89	20.31	17.26	19.47	19.89	18.13	18.38	20.38	17.56	13.91	19.09	19.78	18.38	17.91
Di	33.95	26.94	27.86	30.70	30.09	27.52	27.56	27.67	30.00	24.81	23.46	24.26	20.26	23.50	25.09	26.89	30.00
Hy	25.37	26.30	23.93	25.20	24.62	24.28	23.39	24.87	23.17	25.86	25.89	25.68	15.42	26.96	24.74	22.71	19.08
Mt	2.93	2.62	2.65	2.78	2.70	2.61	2.74	2.61	2.80	2.67	2.61	2.64	1.75	2.77	2.73	2.55	2.39
Cm	0.13	0.15	0.13	0.13	0.15	0.15	0.15	0.15	0.13	0.15	0.15	0.15	0.13	0.13	0.13	0.13	0.13
Il	1.39	1.44	1.46	1.44	1.41	1.44	1.50	1.46	1.46	1.50	1.50	1.46	1.22	1.48	1.52	1.46	1.44
Ap	0.24	0.24	0.26	0.26	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	1.92	0.24	0.26	0.24	0.24
Py	0.04	0.04	0.09	0.05	0.04	0.06	0.04	0.02	0.04	0.06	0.07	0.13	0.21	0.04	0.09	0.06	0.07

a. Total iron as Fe₂O₃

b. Figure given is LOI₁.

c. Data for norms recalculated volatile free with the Fe₂O₃/FeO ratio set to 0.20. The data also includes NiO, Cr₂O₃ and S. - Not determined.

Table 2-2. Trace Element data and Interelement Ratios for the Pillow Samples

	SC-2		SD-82	SD-83	SD-84	SD-85	SC-8		SC-3		SC-13		SC-5		SC-11		
	Margin	Core	Core	Core	Core	Core	Margin	Core	Margin	Inter. Core	Core	Ocelli	Margin	Core	Margin	Core	
S	149	189	469	269	203	300	191	144	182	337	348	673	1070	166	523	264	357
Nb	2.4	3.6	3.1	3.7	3.1	2.2	3.2	3.3	3.7	3.4	3.0	2.7	2.4	3.5	3.6	3.3	3.4
Zr	60	62	62	61	61	63	65	64	65	66	65	64	52	66	66	65	64
Y	18.5	18.2	17.3	17.6	17.4	17.1	17.8	18.3	17.6	17.9	18.2	16.8	16.0	18.5	18.8	18.0	18.1
Sr	265	232	156	203	220	175	203	211	149	141	158	111	130	159	137	149	129
Rb ^a	9.4	7.9	<2	<2	5.0	5.2	4.0	13.6	5.1	4.5	7.0	8.0	2.5	7.5	6.9	1.7	1.9
Rb ^b	-	7.8	1.39	-	4.87	-	4.18	13.63	5.24	-	6.40	-	-	7.15	6.86	1.35	1.75
Zn	102	92	139	384	81	77	108	127	89	80	102	90	98	89	82	116	77
Cu	67	172	217	559	115	149	160	135	88	121	199	145	157	100	170	162	126
Ni	209	220	155	184	179	197	194	196	178	190	201	204	214	174	160	178	167
Co	61	62	57	57	57	59	59	60	59	60	59	61	58	60	61	56	59
Cr	622	662	567	618	635	663	695	653	633	646	643	652	661	613	582	623	639
V	192	192	191	193	192	196	201	193	204	195	195	196	172	199	204	192	196
Ba	113	106	21	32	48	59	44	58	31	24	29	33	17	61	40	19	14
Ga	14.1	11.5	12.0	12.2	12.8	11.9	11.0	11.2	10.2	11.4	11.3	10.8	11.4	11.7	12.8	9.6	11.0
Sc	26.3	26.8	28.0	27.5	26.8	27.4	29.6	28.7	28.5	28.3	29.1	27.8	26.6	28.8	28.4	28.5	28.6
Fe ₂ O ₃ /FeO	0.32	0.27	0.26	0.29	0.29	0.23	0.16	0.17	0.17	0.16	0.19	0.19	-	0.19	0.18	0.19	0.21
CaO/Al ₂ O ₃	1.22	0.95	0.93	1.10	1.06	0.93	0.95	0.97	1.03	0.87	0.83	0.86	0.80	0.83	0.87	0.89	0.95
Si/Al	4.2	4.2	4.2	4.2	4.3	4.2	4.1	4.1	4.4	4.1	3.9	4.3	4.8	4.0	4.0	4.0	4.1
Si/Ti	54	55	54	54	56	55	53	54	54	53	53	55	75	54	52	55	56
Al/Ti	13	13	13	13	13	13	13	13	12	13	14	13	15	13	13	14	14
Mg/Ti	14	14	12	13	14	13	11	13	12	12	12	12	10	12	11	12	11
Ca/Ti	21	17	16	19	19	16	17	17	17	15	15	15	17	15	15	16	17
Zr/Y	3.2	3.4	3.6	3.5	3.5	3.7	3.7	3.5	3.7	3.7	3.6	3.8	3.3	3.6	3.5	3.6	3.5
Ti/Zr	71	71	73	72	71	71	71	71	70	71	71	71	73	70	72	70	71
Zr/Sc	2.3	2.3	2.2	2.2	2.3	2.3	2.2	2.2	2.3	2.3	2.2	2.3	2.0	2.3	2.3	2.3	2.2
Ga/Alx10	2.6	2.0	2.0	2.2	2.3	2.1	1.9	1.9	1.8	1.9	1.8	1.8	2.0	1.9	2.1	1.6	1.8
K/Rb ^c	366	388	>403	>502	397	402	434	305	353	402	288	283	478	325	337	571	502
K/Ba	30	29	38	31	41	36	39	71	58	75	70	69	70	40	58	51	71
Rb/Sr ^c	0.035	0.034	<0.013	<0.010	0.023	0.030	0.020	0.064	0.034	0.032	0.044	0.072	0.019	0.048	0.050	0.011	0.015

a. Analysis by X-Ray Fluorescence.

b. Analysis by Isotope Dilution (Allsopp, 1978. pers. com.)

c. Ratios calculated using the XRF Rb data.

- Not determined.

TABLE 2-3. Major and Trace Element data for the Leached Pillow Samples.

	SC-2		SC-5	
	Margin	Core	Margin	Core
SiO ₂	50.79	53.03	52.82	53.70
TiO ₂	0.708	0.741	0.754	0.790
Al ₂ O ₃	10.12	10.72	11.17	11.49
Fe ₂ O ₃ ^a	12.55	10.91	11.64	11.68
MnO	0.199	0.165	0.177	0.167
MgO	9.97	9.35	8.82	8.68
CaO	12.46	10.15	9.44	9.96
Na ₂ O	1.29	2.57	2.76	2.61
K ₂ O	0.435	0.393	0.220	0.245
P ₂ O ₅	0.048	0.045	0.032	0.031
LOI ^b	1.77	1.62	1.27	1.11
H ₂ O-	0.00	0.00	0.11	0.12
Total	100.34	99.69	99.21	100.58

Trace element data (ppm)

Nb	42.0	2.3	3.2	2.8
Zr	61	63	67	66
Y	18.3	18.8	17.7	18.0
Sr	262	230	162	137
Rb	8.9	7.5	4.3	4.9
Zn	-	-	78	76
Cu	-	-	61	100
Ni	-	-	156	148
Co	-	-	57	58
Cr	-	-	609	595
V	-	-	194	208
Ba	67	67	43	36
Ga	14.0	11.3	10.7	11.6
Sc	26.3	27.8	28.9	28.6

a. Total iron as Fe₂O₃.

b. LOI = Loss on ignition at 1000 C.

- Not determined.

Table 2-4. Estimates of the Analytical Error (AE) average pillow composition and the spread in the data from all the pillow samples.

<u>(wt.%)</u>	<u>4σ</u>	<u>Average</u>	<u>(4σ/Ave).100</u>	<u>RS</u>
SiO ₂	1.0	53.34	1.9	4.8
TiO ₂	0.04	0.77	5.1	3.9
Al ₂ O ₅	0.5	11.38	4.4	8.1
Fe ₂ O ₃	0.45	1.97	22.8	48.7
FeO	0.1	9.10	1.1	17.1
MnO	0.015	0.18	8.3	24.5
MgO	0.5	9.45	5.3	15.6
CaO	0.2	10.82	1.9	28.8
Na ₂ O	0.1	2.48	4.0	67.7
K ₂ O	0.02	0.25	7.9	156.1
P ₂ O ₅	0.012	0.10	11.9	-1.9
H ₂ O	0.12	-	-	-
CO ₂	0.28	-	-	-
<u>(ppm)</u>				
S	8.0	304.	2.6	171.5
Nb	1.2	3.3	36.5	4.0
Zr	2.8	65.	4.3	2.8
Y	2.4	18.3	13.1	-2.0
Sr	3.6	179.	2.0	87.5
Rb	1.0	6.4	15.6	174.7
Zn	2.0	117.	1.7	268.3
Cu	2.8	172.	1.6	292.9
Ni	4.0	191.	2.1	33.9
Co	4.8	61.	7.9	4.5
Cr	8.0	648.	1.2	17.0
V	5.2	200.	2.6	3.9
Ba	2.0	47.	4.3	214.5
Ga	0.4	11.9	3.4	36.9
Sc	1.0	28.7	3.5	7.5

TABLE 2-5. Comparison of the SC-2 margin elements with those of the average "fresher" pillows

	<u>SiO₂%</u>	<u>TiO₂%</u>	<u>Zr ppm</u>
SC-2 margin composition from Tables 1 and 2	49.50	0.711	60
SC-2 margin recalculated volatile free and to 100%	50.95	0.732	62
Above recalculated after removal of 5.7 wt.% CaO+Fe ₂ O ₃ in the ratio $\frac{Fe_2O_3}{CaO} = 0.27$	54.04	0.776	66
Average "fresher" pillow composition recalculated volatile free and to 100%	53.84	0.780	66

Table 3-1. Olivine compositions in sample HSS-535

	<u>Grain 1</u>		<u>Grain 2</u>		<u>Grain 3</u>	
	<u>Core</u>	<u>Margin</u>	<u>Core</u>	<u>Margin</u>	<u>Core</u>	<u>Margin</u>
SiO ₂	39.62	39.28	39.91	38.90	40.56	40.57
FeO	7.84	8.69	8.72	9.37	8.53	8.78
MnO	0.16	-	-	-	-	-
MgO	50.27	50.06	49.79	49.22	50.21	49.78
CaO	0.25	0.26	0.25	0.29	0.27	0.29
Cr ₂ O ₃	0.17	0.18	0.19	0.20	0.18	0.18
NiO	0.46	0.45	0.44	0.44	0.45	0.43
Total	98.77	98.92	99.30	98.42	100.20	100.03
Mole % Fosterite	92.0	91.1	91.1	90.4	91.3	91.0

- not determined

Table 3-2. Major element and Normative mineral data for the samples from Stuart's flow and the basal contact sample HSS-530. The major element data has been recalculated to 100 % volatile free.

	<u>HSS-531</u>	<u>HSS-532</u>	<u>HSS-533</u>	<u>HSS-534</u>	<u>HSS-535</u>	<u>HSS-536</u>	<u>Wtd. Ave.</u>	<u>HSS-530</u>
SiO ₂	47.77	47.72	47.98	47.38	47.38	46.74	47.50	47.06
TiO ₂	0.38	0.38	0.40	0.35	0.35	0.30	0.36	0.36
Al ₂ O ₃	4.26	4.25	4.32	3.81	3.80	3.29	3.94	3.96
Fe ₂ O ₃	1.95	1.88	1.99	1.74	1.76	1.84	1.87	1.99
FeO ^a	9.76	9.42	9.95	8.70	8.78	9.21	9.33	9.93
MnO	0.19	0.19	0.19	0.19	0.19	0.18	0.19	0.19
MgO	27.62	28.14	25.65	30.87	30.78	31.68	28.93	28.71
CaO	7.29	7.21	8.72	6.24	6.26	6.06	7.14	7.01
Na ₂ O	0.19	0.20	0.21	0.10	0.08	0.07	0.14	0.12
K ₂ O	0.02	0.02	0.03	0.03	0.03	0.01	0.03	0.02
P ₂ O ₅	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02
S	0.03	0.04	0.03	0.03	0.03	0.02	0.03	0.05
Cr ₂ O ₃	0.34	0.34	0.37	0.32	0.32	0.35	0.35	0.36
NiO	0.19	0.19	0.15	0.22	0.22	0.23	0.19	0.23
Total	100.01	100.00	100.00	100.00	100.00	100.00	100.00	100.00
H ₂ O ⁺	6.79	7.01	6.29	8.59	8.96	8.86	-	7.66
CO ₂	0.22	0.20	0.36	0.29	0.67	0.28	-	0.25
L.O.I.	6.20	6.26	5.12	7.69	7.71	8.03	-	7.07
Norms (volatile free)								
Cr	0.12	0.12	0.18	0.18	0.18	0.06	0.15	0.12
Pl	12.32	12.33	12.53	10.70	10.60	9.23	11.21	11.22
Di	20.14	19.87	25.79	16.62	16.65	16.94	20.08	19.43
Hy	33.34	32.48	30.57	32.49	32.90	29.73	31.50	30.92
Ol	29.92	31.12	26.63	36.24	35.87	40.20	33.06	34.05
Mt	2.83	2.73	2.89	2.52	2.55	2.67	2.71	2.89
Cm	0.50	0.50	0.54	0.47	0.47	0.52	0.51	0.53
Il	0.72	0.72	0.76	0.66	0.66	0.52	0.67	0.68
Ap	0.05	0.05	0.05	0.05	0.05	0.02	0.04	0.05
Fy	0.06	0.07	0.06	0.06	0.06	0.04	0.06	0.09

a. Fe analysed as total Fe; Fe₂O₃ and FeO calculated on the basis that FeO/Fe₂O₃ = 0.20.

Table 3-3. Trace element data and some inter-element ratios for the samples from Stuart's flow and the basal contact sample HSS-530. The trace element data has been recalculated volatile free.

	<u>HSS-531</u>	<u>HSS-532</u>	<u>HSS-533</u>	<u>HSS-534</u>	<u>HSS-535</u>	<u>HSS-536</u>	<u>Wtd. Ave.</u>	<u>HSS-530</u>
(ppm)								
Nb	1.9	1.7	2.4	1.3	1.9	1.6	1.9	2.3
Zr	26.8	26.8	29.7	22.8	22.9	19.2	24.9	25.9
Y	7.5	7.0	9.3	4.8	4.8	4.9	6.6	8.2
Sr	32	29	33	25	25	28	29	25
Rb	1.8	1.7	1.2	1.1	<1.0	0.9	<1.3	0.9
Zn	92	81	77	74	70	81	77	87
Cu	92	62	123	73	66	82	90	45
Co	121	125	108	113	114	124	115	126
V	113	112	119	105	106	90	108	106
Ba	3.8	5.3	4.8	36	35	55	25	8.1
Ga	5.0	5.0	5.5	4.9	4.6	4.3	4.9	5.0
Sc	21.9	21.9	23.8	19.5	19.8	20.1	21.4	20.7
<u>Ratios</u>								
CaO/Al ₂ O ₃	1.7	1.7	2.0	1.6	1.6	1.8	1.8	1.8
Al/Ti	9.8	10.0	9.4	9.5	9.6	9.6	9.7	9.7
Ti/Zr	82	85	84	92	93	95	87	83
Ti/V	20	20	20	20	21	20	20	20
Si/O (Atomic)	0.291	0.291	0.294	0.287	0.287	0.285	0.289	0.288

Table 3-4a. Least squares approximation of the amount of Fo₉₂ that must be removed from the initial magma (Wtd. Ave.) to obtain the random spinifex (A_{2r}) composition (ave. of HSS-531 and HSS-532).

<u>Oxide</u>	<u>Observed</u>	<u>Estimated</u>	<u>Difference</u>	<u>Trace element</u>	<u>Observed</u>	<u>Calculated</u>
SiO ₂	47.84	47.85	0.01	Zr	26.8	26.1
TiO ₂	0.38	0.38	0.00	Y	7.3	6.9
Al ₂ O ₃	4.27	4.13	-0.14	V	113	113
FeO	11.34	11.16	-0.18	Ga	5.0	5.1
MnO	0.19	0.19	0.00	Sc	21.9	22.4
MgO	27.88	27.90	0.02	<u>Parameters of the 'Mix' calculation</u>		
CaO	7.26	7.46	0.20	<u>Comp.</u>	<u>Wt. %</u>	<u>S.D.</u>
Cr ₂ O ₃	0.34	0.35	0.01	Init. Magma	100.00	-
$\Sigma (\text{Calc.} - \text{Obs.})^2 = 0.09$				Fo ₉₂	-4.58	0.47
				A _{2r}	95.63	0.53

Table 3-4b. Least squares approximation of the amount of Fo₉₂ that must be removed from the initial magma to obtain the lower plate spinifex (A_{2p}) composition (HSS-533).

<u>Oxide</u>	<u>Observed</u>	<u>Estimated</u>	<u>Difference</u>	<u>Trace element</u>	<u>Observed</u>	<u>Calculated</u>
SiO ₂	48.08	48.33	0.25	Zr	29.7	28.6
TiO ₂	0.40	0.41	0.01	Y	9.3	7.6
Al ₂ O ₃	4.32	4.50	0.18	V	119	124
FeO	11.76	11.40	-0.36	Ga	5.5	5.6
MnO	0.19	0.19	0.00	Sc	23.8	24.6
MgO	25.70	25.57	-0.13	<u>Parameters of the 'Mix' calculation</u>		
CaO	8.74	8.11	-0.63	<u>Comp.</u>	<u>Wt. %</u>	<u>S.D.</u>
Cr ₂ O ₃	0.37	0.36	-0.01	Init. Magma	100.00	-
$\Sigma (\text{Calc.} - \text{Obs.})^2 = 0.64$				Fo ₉₂	-13.07	1.03
				A _{2p}	87.71	1.17

Table 3-4c.

Least squares approximation of the amount of Fo_{92} that must be added to the initial magma to obtain the upper B zone composition (ave. of HSS-534 and HSS-535).

<u>Oxide</u>	<u>Observed</u>	<u>Estimated</u>	<u>Difference</u>	<u>Trace element.</u>	<u>Observed</u>	<u>Calculated</u>
SiO ₂	47.46	47.25	-0.21	Zr	22.9	22.9
TiO ₂	0.35	0.33	-0.02	Y	4.8	6.1
Al ₂ O ₃	3.82	3.65	-0.17	V	106	99
FeO	10.33	10.84	0.51	Ga	4.8	4.5
MnO	0.19	0.19	0.00	Sc	19.7	19.6
MgO	30.88	30.96	0.08	<u>Parameters of the 'Mix' calculation</u>		
CaO	6.26	6.62	0.36	<u>Comp.</u>	<u>Wt. %</u>	<u>S.D.</u>
Cr ₂ O ₃	0.32	0.33	0.01	Init. Magma	100.00	-
			$\Sigma (\text{Calc.} - \text{Obs.})^2 = 0.47$	Fo ₉₂	8.94	1.38
				Upper B zone	108.16	1.53

Table 3-4d. Least squares approximation of the amount of Fo_{92} that must be added to the initial magma to obtain the lower B zone composition (HSS-536).

<u>Oxide</u>	<u>Observed</u>	<u>Estimated</u>	<u>Difference</u>	<u>Trace element</u>	<u>Observed</u>	<u>Calculated</u>
SiO ₂	46.83	46.79	-0.04	Zr	19.2	21.8
TiO ₂	0.30	0.32	0.02	Y	4.9	5.8
Al ₂ O ₃	3.30	3.47	0.17	V	90	94
FeO	10.89	10.68	-0.21	Ga	4.3	4.3
MnO	0.18	0.19	0.01	Sc	20.1	18.7
MgO	31.74	31.80	0.06	<u>Parameters of the 'Mix' calculations</u>		
CaO	6.07	6.31	0.24	<u>Comp.</u>	<u>Wt. %</u>	<u>S.D.</u>
Cr ₂ O ₃	0.35	0.32	-0.03	Init. Magma	100.00	-
$\Sigma (\text{Calc.} - \text{Obs.})^2 = 0.14$				Fo ₉₂	14.35	0.82
				Lower B zone	113.83	0.92

Table 3-5. Observed and calculated D_{Ni} values for the olivine (Fo₉₂) - random spinifex textured sample (HSS-531) pair from Stuart's flow.

<u>Source</u>	<u>D_{Ni}</u>
Observed	2.4
Calculated from Hart and Davis (1978) equation	3.6
Calculated from Arndt (1977) equation	3.7
Calculated from equation 2 in text	2.3

Table 3-6a. Major element and normative mineral data for the samples from Tony's Flow.

The major element data have been recalculated to 100% volatile free.

	SC-6A	HSS-C1	SC-6B	HSS-C2	SC-6C	HSS-C3	Wtd. Ave.
SiO ₂	53.12	52.32	52.71	54.74	50.03	53.09	52.63
TiO ₂	0.60	0.66	0.76	0.51	0.55	0.54	0.63
Al ₂ O ₃	6.53	6.77	7.99	4.88	6.27	5.82	6.67
Fe ₂ O ₃	2.02	1.97	2.28	1.76	2.06	1.97	2.04
FeO ^a	10.08	9.84	11.38	8.82	10.28	9.84	10.20
MnO	0.22	0.24	0.19	0.23	0.20	0.19	0.22
MgO	14.59	14.29	11.98	15.18	18.74	16.27	14.55
CaO	11.04	12.04	10.54	12.06	10.90	10.58	11.26
Na ₂ O	1.43	1.45	1.90	1.45	0.47	1.34	1.42
K ₂ O	0.04	0.08	0.08	0.05	0.03	0.06	0.06
P ₂ O ₅	0.06	0.07	0.07	0.03	0.06	0.04	0.06
S	0.01	ND	0.01	ND	0.02	0.01	<0.01
Cr ₂ O ₅	0.20	0.22	0.10	0.26	0.28	0.19	0.20
NiO	0.05	0.06	0.03	0.04	0.10	0.06	0.05
TOTAL	100.00	100.00	100.00	99.99	100.00	100.00	-
H ₂ O ⁺	2.86	2.56	2.82	3.15	4.35	3.15	-
CO ₂	0.15	0.25	0.23	0.44	0.17	0.15	-
LOI	1.57	1.52	1.21	1.51	3.05	2.24	-
NORMS							
QZ	1.37	-	1.26	2.72	-	0.24	-
OR	0.24	0.47	0.47	0.30	0.18	0.35	-
PL	23.38	24.00	29.11	18.93	18.89	21.03	-
DI	34.78	38.36	31.59	42.57	31.11	34.22	-
HY	35.70	32.00	32.51	31.53	37.25	39.89	-
OL	-	0.59	-	-	7.93	-	-
MT	2.93	2.86	3.31	2.55	2.99	2.86	-
CM	0.29	0.32	0.15	0.38	0.41	0.28	-
IL	1.14	1.25	1.44	0.97	1.04	1.03	-
AP	0.14	0.17	0.17	0.07	0.14	0.09	-
PY	0.02	-	0.02	-	0.04	0.02	-

a FeO calculated such that Fe₂O₃/FeO = 0.2
 ND Not detected.

Table 3-6b. Trace element data and some inter-element ratios for the samples from Tony's Flow.

The trace element data has been recalculated volatile free.

(ppm)	SC-6A	HSS-C1	SC-6B	HSS-C2	SC-6C	HSS-C3	Wtd. Ave.
Nb	2.2	3.5	3.7	2.4	2.2	2.3	2.9
Zr	46.0	51	60	37.6	42.6	43.0	49.0
Y	13.3	15.8	17.6	12.2	13.5	12.6	14.8
Sr	74	45	62	34.5	20.8	53	51
Rb	0.8	<1.0	1.2	<1.0	1.0	1.9	<1.0
Zn	117	132	202	119	98	85	139
Cu	40.0	109	245	103	58	77	118
Ni	412	453	202	299	752	492	402
Co	80	78	76	66	97	83	79
Cr	1384	1483	669	1813	1948	1316	1366
V	161	186	215	150	159	154	178
Ba	56	35.8	32.1	17.5	7.3	23.5	33.0
Ga	8.3	7.6	10.0	6.1	7.2	7.2	8.1
Sc	31.1	33.5	39.9	32.0	28.8	27.4	33.6
RATIOS							
CaO/Al ₂ O ₃	1.69	1.78	0.98	2.47	1.74	1.82	1.65
Al/Ti	9.6	9.1	10.9	8.4	10.1	9.5	9.7
Ti/Zr	78	78	76	81	77	75	78
Ti/V	22	21	21	20	21	21	21

Table 3-7a. Least squares approximation of the amount of olivine, clinopyroxene and quartz that must be added to or removed from the initial magma (SC-6A) to obtain HSS-C1 composition.

<u>Oxide</u>	<u>Observed</u>	<u>Estimated</u>	<u>Difference</u>	<u>Parameters of the 'Mix' calculations</u>		
				<u>Comp.</u>	<u>Wt.%</u>	<u>S.D.</u>
SiO ₂	52.42	52.42	0.00	Initial Magma	99.28	1.70
TiO ₂	0.66	0.60	-0.06	Clinopyroxene	5.66	1.32
Al ₂ O ₃	6.78	6.56	-0.22	Olivine	-2.77	0.52
FeO	11.63	11.80	0.17	Quartz	-2.36	0.48
MnO	0.24	0.22	-0.02	HSS-C1	100.00	-
MgO	14.32	14.28	-0.04			
CaO	12.06	12.07	0.01			

$$\Sigma (\text{Calc.} - \text{Obs.})^2 = 0.08$$

Table 3-7b. Least squares approximation of the amount of olivine, clinopyroxene and quartz that must be added to SC-6B composition to obtain the initial magma (SC-6A).

<u>Oxide</u>	<u>Observed</u>	<u>Estimated</u>	<u>Difference</u>	<u>Trace Element</u>	<u>Observed</u>	<u>Calculated</u>
SiO ₂	52.83	52.83	0.00	Zr	60	56
TiO ₂	0.76	0.73	-0.03	Y	17.6	15
Al ₂ O ₃	8.01	8.10	0.09	Ni	202	252
FeO	13.46	13.40	-0.06	Co	76	75
MnO	0.19	0.24	0.05	V	215	182
MgO	12.01	12.03	0.02	Ga	10.0	10
CaO	10.56	10.56	0.00	Sc	39.9	34

$$\Sigma (\text{Calc.} - \text{Obs.})^2 = 0.02$$

Parameters of the 'Mix' calculations

<u>Comp.</u>	<u>Wt.%</u>	<u>S.D.</u>
SC-6B	78.74	0.59
Clinopyroxene	14.08	0.46
Olivine	5.37	0.18
Quartz	1.94	0.17
Initial Magma	100.00	-

Table 3-7c. Least squares approximation of the amount of olivine, clinopyroxene and quartz that must be added to the initial magma (SC-6A) to obtain HSS-C2 composition.

<u>Oxide</u>	<u>Observed</u>	<u>Estimated</u>	<u>Difference</u>	<u>Parameters of the 'Mix' calculations</u>		
SiO ₂	54.84	54.84	0.00	<u>Comp.</u>	<u>Wt.%</u>	<u>S.D.</u>
TiO ₂	0.51	0.49	-0.02	Initial Magma	75.94	2.28
Al ₂ O ₃	4.89	5.19	0.30	Clinopyroxene	18.82	1.77
FeO	10.42	10.20	-0.22	Olivine	1.35	0.70
MnO	0.23	0.20	-0.03	Quartz	3.73	0.64
MgO	15.21	15.27	0.06	HSS-C2	100.00	-
CaO	12.08	12.07	-0.01			

$$\Sigma (\text{Calc.} - \text{Obs.})^2 = 0.15$$

Table 3-7d. Least squares approximation of the amount of olivine, clinopyroxene and quartz that must be added to or removed from the initial magma to obtain SC-6C composition.

<u>Oxide</u>	<u>Observed</u>	<u>Estimated</u>	<u>Difference</u>	<u>Parameters of the 'Mix' calculations</u>		
SiO ₂	50.13	50.13	0.00	<u>Comp.</u>	<u>Wt.%</u>	<u>S.D.</u>
TiO ₂	0.55	0.56	0.01	Initial Magma	91.85	1.72
Al ₂ O ₃	6.28	6.05	-0.23	Clinopyroxene	3.78	1.33
FeO	12.16	12.33	0.17	Olivine	9.80	0.53
MnO	0.20	0.22	0.02	Quartz	-4.74	0.48
MgO	18.78	18.74	-0.04	SC-6C	100.00	-
CaO	10.92	10.93	0.01			

$$\Sigma (\text{Calc.} - \text{Obs.})^2 = 0.08$$

Table 3-7e. Least squares approximation of the amount of olivine, clinopyroxene and quartz that must be added to the initial magma (SC-6A) to obtain HSS-C3 composition.

<u>Oxide</u>	<u>Observed</u>	<u>Calculated</u>	<u>Difference</u>	<u>Parameters of 'Mix' calculations</u>		
SiO ₂	53.19	53.19	0.00	<u>Comp.</u>	<u>Wt.%</u>	<u>S.D.</u>
TiO ₂	0.54	0.55	0.01	Initial Magma	90.13	0.78
Al ₂ O ₃	5.83	5.93	0.10	Clinopyroxene	3.12	0.61
FeO	11.64	11.56	-0.08	Olivine	5.45	0.24
MnO	0.19	0.21	0.02	Quartz	1.34	0.22
MgO	16.30	16.32	0.02	HSS-C3	100.00	-
CaO	10.60	10.60	0.00			

$$\Sigma (\text{Calc.} - \text{Obs.})^2 = 0.02$$

Table 4-1. Comparison of high-Mg Meimechite with komatiite HSS-109 from Barberton and Ultramafite from South Greenland (Upton and Thomas, 1973).

Major elements	Meimechite 1202 (dyke)	Ultramafic Komatiite	Ultramafite 85935
SiO ₂	40.91	46.53	39.23
TiO ₂	2.63	0.28	3.74
Al ₂ O ₃	2.83	3.11	6.01
Fe ₂ O ₃ ^a	2.08	1.89	2.88
FeO	10.40	9.47	14.37
MnO	0.18	0.17	0.24
MgO	32.60	32.91	23.98
CaO	6.20	4.77	7.49
Na ₂ O	0.09	0.07	0.68
K ₂ O	1.18	0.01	0.69
P ₂ O ₅	0.32	0.02	0.43
Cr ₂ O ₃	0.34	0.49	0.12
NiO	0.27	0.25	0.12
Total	100.00	100.00	100.00
H ₂ O ⁻	0.47	0.18	-
H ₂ O ⁺	3.53	9.18	3.38
CO ₂	0.23	1.10	0.18
Orig. Total	100.24	99.74	100.36
<u>Trace elements</u>			
Nb	45.9	1.0	-
Zr	215	20.1	186
Y	15.1	7.5	31
Sr	583	36.9	352
Rb	31.7	0.6	21
Zn	85	67	93
Cu	88	<1.0	-
Ni	2132	2001	973
Co	133	136	85
V	169	84	259
Ga	8.3	2.0	-
<u>Ratios</u>			
CaO/Al ₂ O ₃	2.19	1.53	1.25

^a Fe₂O₃ content calculated such that FeO/Fe₂O₃ = 0.2

TABLE 4-2. SUMMARY OF PARAMETERS^a USED FOR CLASSIFYING KOMATIITIC LAVAS FROM THE ONVERWACHT GROUP.

<u>PARAMETER</u>	<u>ULTRAMAFIC KOMATIITES</u>	<u>HIGH-Mg MAFIC KOMATIITES</u>	<u>LOW-Mg MAFIC KOMATIITES</u>
Textures	Non-cumulate samples and aphyric rocks (pillows and chilled margins) as well as olivine spinifex textured lavas	Non-cumulate and aphyric rocks (pillows and chilled margins)	Non-cumulate and aphyric rocks (pillows and chilled margins) as well as clinopyroxene (?) spinifex textured lavas
Main Phenocrysts ^b	Olivine	Clinopyroxene and orthopyroxene (?)	clinopyroxene
Minor Minerals ^b	Spinel, clinopyroxene and orthopyroxene	Spinel, olivine (?) and plagioclase	Spinel, plagioclase and olivine
Normative Minerals	Olivine (mafic minerals ~90%)	Olivine or quartz	Quartz
MgO wt. %	>24%	24-19(?)%	16(?) - 8%
Al ₂ O ₃ wt. %	≤5%	≤9%	≤12%
Cr ppm	>2200 ppm	>1700 ppm	>600 ppm
<u>Additional Information</u>			
CaO/Al ₂ O ₃	1.2 - 2.5	0.8 - 2.6	0.8 - 1.8

^a Where doubt exists about a certain feature it is followed by (?)

^b Primary igneous minerals have often been pseudomorphed by secondary greenschist facies mineral assemblages.

Table 5-1.

Olivine, Clinopyroxene and Orthopyroxene compositions in Ultramafic Komatiite Rocks

Sample	OLIVINE				CLINOPYROXENE			ORTHOPIYROXENE	
	HSS-535	HSS-8	VU-32A	HSS-28	HSS-28	HSS-31	HSS-27	HSS-27	SD-76
n	6	11	10	6	10	4	9	4	4
SiO ₂	39.81	40.00	39.77	39.97	53.31	51.46	52.17	51.99	56.75
TiO ₂	-	nd	0.02	nd	0.27	0.64	0.46	0.46	0.03
Al ₂ O ₃	-	0.05	0.06	0.05	1.38	3.08	2.18	5.06	0.86
FeO*	8.66	11.02	9.81	10.60	5.89	5.23	6.50	11.96	6.86
MnO	0.16	0.15	0.13	0.16	0.14	0.14	0.14	0.18	0.14
MgO	49.89	47.73	48.96	47.56	19.50	18.25	19.04	28.10	34.27
CaO	0.27	0.31	0.29	0.27	18.05	19.30	17.67	1.88	1.01
N ₂ O	-	-	-	-	0.20	0.32	0.28	0.07	0.07
K ₂ O	-	-	-	-	nd	0.01	nd	nd	nd
Cr ₂ O ₃	0.18	0.12	0.17	0.13	0.55	0.78	0.80	0.30	0.50
NiO	0.445	0.367	-	0.393	-	-	0.150	0.125	-
Total	99.42	99.75	99.21	99.13	99.29	99.20	99.39	100.13	100.49
100Mg/(Mg+Fe)	91.2	88.5	89.9	88.9	85.5	86.1	83.6	80.7	89.9
Range	92.0	89.6	91.4	89.2	87.4	87.1	87.3	82.7	89.9
	90.4	87.0	88.1	88.7	83.0	84.5	79.0	74.3	89.8

- not determined

nd not detected

FeO* is total Fe expressed as FeO.

Table 5-2. Composition of secondary minerals in komatiitic rocks from the Komati Formation.

<u>Mineral</u>	<u>Serpentine</u>	<u>Serpentine</u>	<u>Serpentine</u>	<u>Actinolite</u>	<u>Chlorite</u>	<u>Biotite</u>	<u>Clinozoisite</u>	<u>Clinozoisite</u>
<u>Sample</u>	<u>HSS-8</u>	<u>HSS-27</u>	<u>HSS-28</u>	<u>HSS-56</u>	<u>SC-11</u>	<u>HSS-43</u>	<u>SC-9</u>	<u>SC-11</u>
n	4	1	2	2	1	1	1	1
SiO ₂	43.02	44.70	43.19	44.16	24.76	34.53	39.15	38.88
TiO ₂	-	0.03	0.03	0.17	nd	1.30	0.03	0.09
Al ₂ O ₃	0.31	0.29	0.22	11.01	20.00	18.13	31.00	30.55
FeO*	2.93	3.64	1.76	16.60	21.18	16.05	4.63	4.58
MnO	-	-	0.11	0.25	0.25	0.11	0.10	0.16
MgO	38.23	37.85	39.51	10.75	17.65	13.98	0.05	0.03
CaO	0.10	0.08	0.06	11.61	0.05	0.13	22.89	22.32
Na ₂ O	-	0.05	-	1.11	0.06	0.10	0.04	0.04
K ₂ O	-	nd	-	0.17	0.02	8.19	nd	nd
Cr ₂ O ₃	0.05	0.05	0.14	0.01	0.90	0.17	0.02	0.03
<u>NiO</u>	0.27	-	-	-	-	-	-	-
Total	84.91	86.69	85.00	95.84	84.89	92.69	97.90	96.67

- not determined

nd not detected

FeO* is total Fe expressed as FeO.

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Table 5-3a. Major element and normative mineral data for spinifex-textured and aphyric samples of Ultramafic Komatiite lavas

SAMPLE	HSS-88C	HSS-88A	HSS-533	HSS-95	HSS-90	HSS-89	HSS-531	HSS-532	HSS-530
SiO ₂	49.51	47.95	47.98	47.34	48.21	47.37	47.77	47.72	47.06
TiO ₂	0.39	0.43	0.40	0.27	0.39	0.41	0.38	0.38	0.36
Al ₂ O ₃	4.05	4.64	4.32	4.92	4.18	4.50	4.26	4.25	3.96
Fe ₂ O ₃	1.81	1.98	1.99	2.11	1.99	1.98	1.95	1.88	1.99
FeO	9.06	9.89	9.95	10.56	9.93	9.88	9.76	9.42	9.93
MnO	0.18	0.22	0.19	0.21	0.20	0.20	0.19	0.19	0.19
MgO	24.09	24.96	25.65	25.68	26.08	26.97	27.62	28.14	28.71
CaO	10.07	9.09	8.72	7.39	8.25	7.90	7.29	7.21	7.01
Na ₂ O	0.25	0.16	0.21	0.63	0.13	0.20	0.19	0.20	0.12
K ₂ O	0.03	0.02	0.03	0.10	0.01	0.02	0.02	0.02	0.02
P ₂ O ₅	0.02	0.04	0.02	0.03	0.02	0.03	0.02	0.02	0.02
S	0.03	0.05	0.03	0.03	ND	0.04	0.03	0.04	0.05
Cr ₂ O ₃	0.37	0.40	0.37	0.54	0.42	0.39	0.34	0.34	0.36
NiO	0.15	0.17	0.15	0.19	0.18	0.18	0.19	0.19	0.23
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOI	4.67	4.99	5.12	5.44	5.41	5.72	6.20	6.26	7.07
H ₂ O ⁺	0.27	0.32	0.22	0.31	0.43	0.22	0.34	0.32	0.27
H ₂ O	4.81	5.41	6.29	6.07	6.03	6.70	6.79	7.01	7.66
CO ₂	0.33	0.21	0.36	0.22	0.32	0.33	0.22	0.20	0.25
ORIG. TOTAL	100.45	100.96	100.83	100.14	99.91	100.63	100.73	100.96	100.98
NORMS									
QZ	-	-	-	-	-	-	-	-	-
OR	0.18	0.12	0.18	0.59	0.06	0.12	0.12	0.12	0.12
PL	11.96	13.24	12.53	15.63	11.89	13.01	12.32	12.33	11.22
DI	31.84	26.26	25.79	20.88	23.90	22.03	20.14	19.87	19.43
HY	33.08	31.18	30.57	25.59	34.72	29.64	33.34	32.48	30.92
OL	18.93	24.72	26.63	32.80	25.12	30.84	29.92	31.12	34.05
MT	2.62	2.87	2.89	3.06	2.89	2.87	2.83	2.73	2.89
CM	0.54	0.59	0.54	0.80	0.62	0.57	0.50	0.50	0.53
IL	0.74	0.82	0.76	0.51	0.74	0.78	0.72	0.72	0.68
AP	0.05	0.09	0.05	0.07	0.05	0.07	0.05	0.05	0.05
PY	0.06	0.09	0.06	0.06	-	0.07	0.06	0.07	0.09
T ^o _c	1495	1511	1524	1525	1532	1549	1561	1571	1581
z (poises) ^a	4.08	3.62	3.54	3.68	2.87	2.75	2.81	2.82	1.91
ρ ^a	2.99	3.02	3.02	3.03	3.00	3.01	3.01	3.00	3.00

ND not detected

- not determined

a calculated to nearest 50^oc interval.

b FeO calculated such that Fe₂O₃/FeO = 0.2

Table 5-3a. (Cont.)

SAMPLE	HSS-523	AU-5	HSS-87	HSS-14	HSS-15	53-J	49-J	HSS-109	HSS-150
SiO ₂	47.38	46.27	46.20	46.64	46.77	48.36	46.30	46.53	44.86
TiO ₂	0.38	0.42	0.35	0.35	0.33	-	0.19	0.28	0.28
Al ₂ O ₃	4.00	3.83	3.57	3.77	3.42	3.04	3.57	3.11	3.12
Fe ₂ O ₃	1.91	2.02	2.07	1.90	1.88	1.82	1.73	1.89	2.31
FeO	9.53	10.08	10.34	9.51	9.38	9.12	8.68	9.47	11.53
MnO	0.17	0.21	0.20	0.20	0.19	-	0.21	0.17	0.18
MgO	29.42	29.72	30.60	30.79	31.51	32.44	32.86	32.91	33.01
CaO	6.46	6.67	5.54	6.01	5.67	4.61	5.08	4.77	3.76
Na ₂ O	0.15	0.13	0.20	0.19	0.12	0.26	0.49	0.07	0.01
K ₂ O	0.01	0.03	0.01	0.02	0.08	0.07	0.18	0.01	0.01
F ₂ O ₅	0.03	-	0.03	0.02	0.03	-	0.01	0.02	0.03
S	0.02	0.05	0.04	0.01	0.03	0.06	-	0.03	0.04
Cr ₂ O ₃	0.33	0.33	0.67	0.35	0.34	-	0.43	0.49	0.64
NiO	0.22	0.23	0.20	0.23	0.27	0.22	0.27	0.25	0.22
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOI ₋	7.01	-	7.43	7.09	7.57	-	-	9.13	8.73
H ₂ O ₊	0.20	0.18	0.29	0.35	0.48	0.15	0.55	0.18	0.32
H ₂ O	7.68	9.03	-	7.41	-	7.96	6.63	9.18	9.43
CO ₂	0.34	-	-	0.89	-	-	0.20	1.10	0.13
ORIG. TOTAL	101.24	99.42	100.02	100.29	99.14	98.29	100.05	99.74	99.69
NORMS									
QZ	-	-	-	-	-	-	-	-	-
OR	0.06	0.18	0.06	0.12	0.47	0.41	1.1	0.06	0.06
PL	11.48	10.88	10.51	10.98	9.57	9.12	11.2	8.73	8.52
DI	17.19	18.53	14.68	16.12	15.37	12.65	14.6	12.20	7.97
HY	33.33	26.92	29.98	28.89	30.47	37.24	21.7	32.99	31.38
OL	33.86	39.16	39.98	39.87	40.14	37.80	50.1	41.90	47.08
MT	2.77	2.93	3.00	2.75	2.73	2.64	1.4	2.74	3.35
CM	0.49	0.49	0.99	0.52	0.50	-	0.6	0.72	0.94
IL	0.72	0.80	0.66	0.66	0.63	-	0.3	0.53	0.53
AP	0.07	-	0.07	0.05	0.07	-	-	0.05	0.07
PY	0.04	0.09	0.07	0.02	0.06	0.11	-	0.06	0.07
T ^o c	1595	1600	1617	1621	1634	1652	1650	1660	1662
z (poises) ^a	1.96	1.78	1.78	1.84	1.28	1.40	-	1.23	1.08
ρ ^a	2.99	3.01	3.02	3.00	2.98	2.96	-	2.99	3.04

Table 5-3b.

Trace element data^a (PPM) and inter-element ratios for spinifex-textured and aphyric samples of Ultramafic Komatiite lavas

SAMPLE	HSS-88C	HSS-88A	HSS-533	HSS-95	HSS-90	HSS-89	HSS-531	HSS-532	HSS-530
Nb	2.5	1.9	2.4	<1.0	2.2	1.9	1.9	1.7	2.3
Zr	27.2	29.6	29.7	12.9	27.9	29.9	26.8	26.8	25.9
Y	8.7	9.4	9.3	5.6	8.1	8.9	7.5	7.0	8.2
Sr	34.5	40.2	32.8	34.3	35.5	33.1	32.2	28.9	24.8
Rb	1.2	0.5	1.2	2.7	<1.0	0.7	1.8	1.7	0.9
Zn	79	79	77	64	78	74	92	81	87
Cu	58	78	123	145	198	63	92	62	45.4
Ni	1145	1305	1141	1499	1426	1375	1467	1497	1780
Co	109	119	108	130	123	120	121	125	126
V	112	125	119	120	116	122	113	112	106
Ba	8.4	<2.0	4.8	5.2	11.8	7.5	3.8	5.3	8.1
Ga	4.8	5.6	5.5	5.0	4.6	5.6	5.0	5.0	5.0
Sc	22.6	-	23.8	19.2	-	-	21.9	21.9	20.7
RATIOS									
CaO/Al ₂ O ₃	2.49	1.96	2.02	1.50	1.97	1.76	1.71	1.70	1.77
Si/Ti	99	87	94	137	96	90	98	98	102
Al/Ti	9.1	9.5	9.4	16.3	9.4	9.8	9.8	9.9	9.8
Fe/Ti	36	35	38	60	39	37	39	38	42
Mg/Ti	62	58	65	96	67	66	73	75	80
Ca/Ti	31	25	26	33	25	23	23	23	23
Ti/Nb	937	1362	996	-	1094	1266	1186	1315	942
Ti/Zr	86	88	82	124	84	81	85	84	82
Ti/Y	271	276	260	286	292	274	305	324	260
Ti/Ni	2.1	2.0	2.1	1.1	1.7	1.8	1.6	1.5	1.2
Ti/Co	22	24	24	14	19	22	20	19	17
Ti/V	21	21	20	14	20	20	20	20	20
Ti/Ga	489	463	458	316	-	438	427	390	450
Ti/Sc	103	-	101	84	-	-	104	104	104
Al/V	191	196	192	217	191	195	200	201	198
Ga/Alx10 ³	22	23	24	19	21	24	22	22	24
Zr/Nb	11	16	12	-	13	16	14	16	11
Zr/Y	3.1	3.2	3.2	2.3	3.4	3.4	3.6	3.8	3.2

- not determined

a data recalculated volatile free.

Table 5-3b. (Cont.)

SAMPLE	HSS-523	AU-5	HSS-87	HSS-14	HSS-15	53-J	49-J	HSS-109	HSS-150
Nb	2.5	<0.9	1.2	<2.0	1.9	<0.9	-	1.0	<1.0
Zr	32.3	33.4	25.2	33.7	26.6	9.7	-	20.1	21.2
Y	7.7	9.2	9.0	9.7	8.1	4.1	-	7.5	6.8
Sr	26.9	14.5	28.5	73	52	15.6	-	36.9	6.9
Rb	1.0	0.9	0.7	<2.0	2.6	2.1	-	0.6	1.0
Zn	78	75	62	<1.0	67	51	85	67	80
Cu	22.6	28.9	30.7	2.5	5.0	18.9	85	<1.0	36
Ni	1696	1802	1579	1833	2095	1706	2122	2001	1745
Co	123	121	137	127	129	128	128	136	159
V	104	107	105	97	94	89	95	84	83
Ba	2.9	5.9	9.0	2.7	9.9	8.0	-	<2.0	35.8
Ga	4.7	4.9	4.5	4.7	4.2	4.1	-	3.8	3.9
Sc	20.6	21.8	-	-	-	-	-	-	14.9
RATIOS									
CaO/Al ₂ O ₃	1.62	1.74	1.55	1.59	1.66	1.52	1.42	1.53	1.21
Si/Ti	97	86	103	104	111	-	190	130	125
Al/Ti	9.3	8.0	9.1	9.6	9.3	-	16.6	9.8	9.7
Fe/Ti	38	37	45	42	44	-	70	52	63
Mg/Ti	78	71	88	89	96	-	174	118	119
Ca/Ti	20	19	19	21	21	-	31	20	16
Ti/Nb	918	-	1749	-	1033	-	-	1647	-
Ti/Zr	70	76	83	62	73	-	-	83	80
Ti/Y	293	274	232	216	241	-	-	224	250
Ti/Ni	1.3	1.4	1.3	1.1	0.9	-	0.5	0.8	1.0
Ti/Co	19	22	17	17	11	-	9	13	12
Ti/V	22	23	17	22	21	-	12	19	21
Ti/Ga	480	518	464	-	462	-	-	441	435
Ti/Sc	111	116	-	-	-	-	-	-	113
Al/V	204	189	180	206	193	181	199	196	199
Ga/Alx10 ⁵	22	24	24	24	23	25	-	23	24
Zr/Nb	13	-	21	-	14	-	-	-	-
Zr/Y	4.2	3.6	2.8	3.5	3.3	2.4	-	2.7	3.1

Major element and normative mineral data for porphyritic Ultramafic Komatiite lavas

Table 5-4a.

Olivine Phyric

SAMPLE	HSS-88B	HSS-535	HSS-534	HSS-536	VU-25	HSS-93	V-2	VU-30A	HSS-8	HSS-13	VU-32A
SiO ₂	47.52	47.38	47.38	46.74	46.57	46.85	46.62	44.63	45.30	45.01	44.38
TiO ₂	0.34	0.35	0.35	0.30	0.33	0.21	0.34	0.26	0.22	0.22	0.45
Al ₂ O ₃	3.75	3.80	3.81	3.29	3.63	4.46	2.35	2.57	2.30	2.49	2.17
Fe ₂ O ₃	1.85	1.76	1.74	1.84	1.92	1.75	1.78	1.85	1.72	1.66	1.68
FeO ^a	9.25	8.78	8.70	9.21	9.61	8.75	8.91	9.23	8.58	8.32	8.39
MnO	0.17	0.19	0.19	0.18	0.21	0.17	0.18	0.19	0.17	0.16	-
MgO	30.64	30.78	30.87	31.68	31.68	32.10	33.18	34.91	36.70	38.20	38.68
CaO	5.74	6.26	6.24	6.06	4.90	4.65	5.74	5.64	4.36	3.14	3.79
Na ₂ O	0.07	0.08	0.10	0.07	0.31	0.18	0.18	0.08	0.10	0.13	0.05
K ₂ O	0.01	0.03	0.03	0.01	0.05	0.04	0.02	0.02	0.01	0.01	-
P ₂ O ₅	0.02	0.02	0.02	0.01	-	0.01	0.02	-	0.02	0.01	-
S	0.06	0.03	0.03	0.02	0.05	0.02	0.07	0.04	0.03	0.02	0.05
Cr ₂ O ₃	0.36	0.32	0.32	0.35	0.41	0.59	0.34	0.31	0.21	0.30	-
NiO	0.22	0.22	0.22	0.23	0.32	0.21	0.26	0.27	0.29	0.32	0.34
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOI ₋	7.62	7.71	7.69	8.03	-	7.73	-	-	8.95	8.64	-
H ₂ O ₊	0.32	0.34	0.36	0.32	0.24	0.27	0.15	0.20	0.25	0.41	0.21
H ₂ O	-	8.96	8.59	8.86	7.04	-	8.62	9.50	-	-	7.76
CO ₂	-	0.67	0.29	0.28	0.36	-	-	-	-	-	-
ORIG. TOTAL	99.73	100.77	101.18	101.03	99.72	98.78	99.29	99.24	98.65	99.72	99.33
NORMS											
QZ	-	-	-	-	-	-	-	-	-	-	-
OR	0.06	0.18	0.18	0.06	0.30	0.24	0.12	0.12	0.06	0.05	-
PL	10.48	10.60	10.70	9.23	10.99	12.77	7.07	7.27	6.64	7.28	6.12
DI	14.64	16.65	16.62	16.94	12.65	9.31	18.06	16.94	12.41	7.37	10.35
HY	36.66	32.90	32.49	29.73	29.74	33.92	26.50	16.54	22.20	23.59	18.67
OL	34.12	35.87	36.24	40.20	42.18	39.87	44.32	55.40	55.36	58.34	61.43
MT	2.68	2.55	2.52	2.67	2.78	2.54	2.58	2.68	2.49	2.41	2.44
CM	0.53	0.47	0.47	0.52	0.60	0.87	0.50	0.46	0.31	0.44	0.85
IL	0.65	0.66	0.66	0.57	0.63	0.40	0.65	0.49	0.42	0.42	-
AP	0.05	0.05	0.05	0.02	-	0.02	0.05	-	0.05	0.02	-
PY	0.11	0.06	0.06	0.04	0.09	0.04	0.13	0.07	0.06	0.04	0.09

ND not detected
- not determined

a FeO calculated such that Fe₂O₃/FeO = 0.2

Table 5-4a. (Cont.)

SAMPLE	Olivine rich			Olivine and Clinopyroxene Phyric							Pyroxenite
	R-13	R-16	20-J	HSS-92	HSS-27	HSS-31	HSS-33	HSS-1	HSS-28	52-J	SD-76
SiO ₂	45.07	44.37	43.52	46.86	44.76	43.83	44.23	46.26	45.30	47.44	56.61
TiO ₂	0.24	0.12	0.06	0.25	0.47	0.32	0.33	0.23	0.25	-	0.04
Al ₂ O ₃	3.05	1.12	2.85	4.51	3.80	3.62	3.82	3.83	2.82	2.47	1.01
Fe ₂ O ₃	2.00	1.60	1.19	1.89	2.06	2.05	1.89	1.44	1.79	1.69	1.13
FeO	9.99	8.02	5.94	9.47	10.29	10.23	9.44	7.22	8.95	8.46	5.67
MnO	0.18	0.12	0.08	0.18	0.19	0.19	0.17	0.13	0.16	-	0.16
MgO	35.42	43.07	45.16	30.27	32.45	34.92	34.94	35.52	36.09	36.28	33.47
CaO	2.64	0.65	0.11	5.17	4.85	3.68	4.19	4.57	3.84	2.70	1.15
Na ₂ O	0.02	0.02	0.02	0.39	0.05	0.03	0.05	0.08	0.02	0.12	0.04
K ₂ O	0.02	0.01	0.02	0.26	0.07	0.04	0.04	0.02	0.02	0.05	0.02
P ₂ O ₅	-	-	0.02	0.02	0.04	0.03	0.03	0.02	0.02	-	ND
S	0.09	0.10	0.06	0.02	0.08	0.02	0.06	0.05	0.03	0.09	ND
Cr ₂ O ₃	1.02	0.37	0.67	0.43	0.55	0.71	0.47	0.35	0.43	0.44	0.63
NiO	0.25	0.42	0.31	0.26	0.34	0.33	0.34	0.27	0.28	0.27	0.07
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOI	-	-	-	7.05	8.73	9.46	9.73	9.35	9.36	-	0.06
H ₂ O ⁺	0.44	0.45	0.57	0.37	0.28	0.61	0.71	0.66	0.31	0.17	0.07
H ₂ O	11.34	11.27	12.86	-	-	-	-	-	-	9.86	-
CO ₂	-	1.50	0.09	-	-	-	-	-	-	-	-
ORIG. TOTAL	99.54	99.29	99.61	99.50	99.54	99.39	100.44	99.36	99.69	97.20	101.15
NORMS											
QZ	-	-	(CO 2.64)	-	-	-	-	-	-	-	0.41
OR	0.12	0.06	0.12	1.54	0.41	0.24	0.24	0.12	0.12	0.30	0.12
PL	8.34	3.11	0.58	13.09	10.36	9.88	10.50	10.71	7.72	7.07	2.86
DI	3.90	0.23	-	12.49	11.00	6.69	8.32	9.87	9.00	5.80	2.51
HY	33.69	26.27	24.72	28.30	25.87	23.48	22.31	27.96	27.24	39.09	91.47
OL	48.88	67.01	68.93	40.62	47.39	54.97	54.36	48.13	52.11	44.45	-
MT	2.90	2.32	1.73	2.74	2.99	2.97	2.74	2.09	2.60	2.45	1.64
CM	1.50	0.54	0.99	0.63	0.81	1.05	0.69	0.52	0.63	0.65	0.93
IL	0.46	0.23	0.11	0.47	0.89	0.61	0.63	0.44	0.47	-	0.08
AP	-	-	0.05	0.05	0.09	0.07	0.07	0.05	0.05	-	-
PY	0.17	0.19	0.11	0.04	0.15	0.04	0.11	0.09	0.06	0.17	-

Trace element data^a (PPM) and inter-element ratios for porphyritic Ultramafic Komatiite lavas

Table 5-4b.

SAMPLE	Olivine Phyrlic										
	HSS-88B	HSS-535	HSS-534	HSS-536	VU-25	HSS-93	V-2	VU-30A	HSS-8	HSS-13	VU-32A
Nb	<1	1.9	1.3	1.6	<0.9	<2.0	<0.9	<0.9	<0.9	1.1	<1.0
Zr	24.2	22.9	22.8	19.2	14.2	13.9	16.6	16.8	15.8	18.9	211
Y	7.7	4.8	4.8	4.9	5.2	3.3	5.1	5.1	4.9	4.7	2.8
Sr	24.2	25.1	24.9	28.3	34.9	17.2	14.4	15.7	11.1	14.5	10.2
Rb	0.6	<0.6	1.1	0.9	4.3	2.7	0.6	0.5	<0.3	0.8	0.7
Zn	76	70	74	81	86	52	61	67	62	57	55
Cu	35	66	73	82	50	14.5	28	38.2	21.4	<2.0	<2.0
Ni	1759	1738	1709	1804	2488	1648	2043	2124	2300	2514	2701
Co	117	114	114	124	130	121	120	153	124	124	125
V	106	106	105	90	95	107	95	100	70	70	73
Ba	15.4	34.9	35.3	55	19.6	14.9	4.9	<2.0	<2.0	3.0	4.5
Ga	4.5	4.6	4.9	4.3	4.6	4.7	3.4	3.3	3.2	3.0	2.8
Sc	-	19.8	19.5	20.1	-	-	-	-	-	-	13.1
RATIOS											
CaO/Al ₂ O ₃	1.53	1.66	1.64	1.84	1.35	1.04	2.44	2.19	1.90	1.26	1.75
Si/Ti	109	106	106	121	110	174	107	134	161	160	77
Al/Ti	9.8	9.5	9.6	9.6	9.8	19	6.0	8.8	9.3	9.9	4.2
Fe/Ti	42	38	38	47	45	64	40	54	60	58	29
Mg/Ti	91	88	89	106	97	154	98	135	168	175	86
Ca/Ti	20	21	21	24	18	27	20	26	24	17	10
Ti/Nb	-	1139	1624	1115	-	-	-	-	-	1193	-
Ti/Zr	84	92	93	95	138	90	124	92	83	70	13
Ti/Y	263	440	443	372	375	376	404	306	270	284	983
Ti/Ni	1.2	1.2	1.2	1.0	0.8	0.8	1.0	0.7	0.6	0.5	1.0
Ti/Co	19	19	20	15	15	10	17	10	11	11	22
Ti/V	19	20	21	20	21	12	22	15	19	19	37
Ti/Ga	449	450	433	478	428	268	600	475	415	442	983
Ti/Sc	-	106	108	89	-	-	-	-	-	-	206
Al/V	187	190	192	193	202	221	130	136	174	188	157
Ga/Alx10 ⁵	23	23	24	25	24	20	27	24	26	23	24
Zr/Nb	-	12	18	12	-	-	-	-	-	17	-
Zr/Y	3.1	4.8	4.8	3.9	2.7	4.2	3.3	3.3	3.2	4.0	75

- not determined

a data recalculated volatile free

Table 5-4b. (Cont.)

SAMPLE	<u>Olivine rich</u>			<u>Olivine and Clinopyroxene Phyrlic</u>							<u>Pyroxenite</u>
	R-13	R-16	20-J	HSS-92	HSS-27	HSS-31	HSS-33	HSS-1	HSS-28	52-J	SD-76
Nb	1.1	<1.0	<1.0	<2.0	<0.8	<2.0	<0.9	<0.9	1.1	<0.9	<1.5
Zr	21.7	8.1	<1.0	15.4	29.7	22.2	20.2	11.1	18.0	10.5	4.3
Y	6.3	1.9	<1.0	5.7	9.7	8.2	6.2	4.5	5.7	4.3	3.6
Sr	10.1	3.2	3.0	29.6	13.7	6.6	9.9	7.6	8.2	10.6	4.5
Rb	0.7	<0.3	1.6	4.1	4.7	3.3	3.5	2.9	2.9	2.5	<1.7
Zn	54	35.0	31.2	59	57	46.4	51	44.0	62	47.3	53
Cu	37.7	<1.5	<1.4	32.9	51	32.8	43.8	13.5	24.7	<2.0	5.0
Ni	1993	3339	2457	2071	2664	2617	2704	2143	2174	2145	559
Co	117	146	113	125	138	151	135	118	136	118	85
V	74	35.0	50	102	127	114	102	93	70	78	32.9
Ba	4.7	2.6	5.8	14.3	8.5	5.1	4.6	<2.0	<2.0	3.7	5.7
Ga	3.9	1.2	2.2	4.7	6.7	5.0	5.1	4.5	3.7	3.8	0.9
Sc	-	-	-	-	-	-	-	-	12.0	-	10.7
RATIOS											
CaO/Al ₂ O ₃	0.87	0.58	0.04	1.15	1.28	1.02	1.10	1.19	1.36	1.09	1.1
Si/Ti	146	288	566	146	74	107	105	157	141	-	1103
Al/Ti	11.2	8.5	43	16	7.1	10	10	15	10	-	22
Fe/Ti	64	102	151	58	34	49	44	48	55	-	217
Mg/Ti	148	361	757	122	69	110	107	155	145	-	842
Ca/Ti	13	6.7	2.2	24	12	14	15	24	19	-	30
Ti/Nb	1354	-	-	-	-	-	-	-	1319	-	-
Ti/Zr	66	87	-	98	95	86	99	125	82	-	63
Ti/Y	229	375	-	265	291	234	324	307	259	-	75
Ti/Ni	0.7	0.2	0.1	0.7	1.1	0.7	0.7	0.7	0.7	-	0.5
Ti/Co.	12	4.8	3.1	12	20	13	15	12	11	-	3.2
Ti/V	19	20	7.0	15	22	17	20	15	21	-	8.2
Ti/Ga	370	600	158	319	420	384	396	307	400	-	-
Ti/Sc	-	-	-	-	-	-	-	-	125	-	22
Al/V	218	169	302	234	158	168	198	218	213	168	162
Ga/Alx10 ⁵	24	20	15	20	33	26	25	22	25	29	17
Zr/Nb	20	-	-	-	-	-	-	-	16	-	-
Zr/Y	3.4	4.3	-	2.7	3.1	2.7	3.3	2.5	3.2	2.4	1.2

Table 5-5a. Major element and normative mineral data for Sandspruit Formation Ultramafic Komatiites.

SAMPLE	87-J	88-J	VU-33	HSS-131	HSS-130	HSS-105	HSS-107	HSS-112	86-J
SiO ₂	48.83	48.61	46.51	48.93	43.75	46.58	46.68	44.19	45.14
TiO ₂	0.72	0.55	0.35	0.61	0.48	0.29	0.32	0.25	0.23
Al ₂ O ₃	3.96	2.89	3.69	3.40	3.39	3.38	3.07	3.25	1.94
Fe ₂ O ₃	2.05	2.04	1.86	1.98	2.39	1.62	1.71	1.85	1.48
FeO ^a	10.23	10.25	9.28	9.92	11.95	8.12	8.56	9.26	7.40
MnO	0.20	0.22	0.21	0.24	0.19	0.14	0.17	0.15	0.10
MgO	23.20	27.06	31.48	31.80	33.82	33.97	34.42	35.28	42.33
CaO	9.59	7.61	5.23	2.52	3.19	5.14	4.35	4.51	0.32
Na ₂ O	0.56	0.44	0.57	ND	0.01	0.05	ND	ND	0.15
K ₂ O	0.06	0.05	0.05	0.01	0.01	0.01	0.01	ND	0.02
P ₂ O ₅	-	-	-	0.06	0.04	0.02	0.03	0.03	-
S	0.09	0.08	0.10	0.02	0.03	0.02	0.10	0.24	0.11
Cr ₂ O ₃	0.38	-	0.39	0.21	0.37	0.35	0.31	0.73	0.39
NiO	0.15	0.20	0.28	0.32	0.38	0.29	0.27	0.26	0.39
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOI ₋	-	-	-	8.36	9.80	8.37	9.30	11.76	-
H ₂ O ₋	0.10	0.34	0.16	0.17	0.18	0.21	0.25	0.29	0.19
H ₂ O ₊	4.31	6.10	6.32	-	-	-	-	9.54	11.84
CO ₂	0.07	0.20	0.50	-	-	-	-	2.87	0.03
ORIG. TOTAL	99.78	99.36	99.89	99.91	99.34	99.61	99.22	99.00	99.86
NORMS									
QZ	-	-	-	-	-	-	-	-	(Co 1.09)
OR	0.35	0.30	0.30	0.06	0.06	0.06	0.06	-	0.12
PL	12.85	9.09	12.05	9.25	9.26	9.39	8.35	8.87	2.86
DI	31.50	24.46	14.58	2.27	5.08	12.97	10.31	10.53	-
HY	28.60	44.85	24.88	57.65	27.67	29.96	34.42	22.19	31.39
OL	21.62	17.29	42.03	26.26	52.84	44.09	43.03	53.59	61.14
MT	2.97	2.84	2.67	2.87	3.47	2.35	2.48	2.68	2.15
CM	0.56	-	0.56	0.31	0.54	0.52	0.46	1.08	0.57
IL	1.37	1.01	0.61	1.16	0.91	0.55	0.61	0.47	0.44
AP	-	-	-	0.14	0.09	0.05	0.07	0.07	-
PY	0.17	0.15	0.17	0.04	0.06	0.04	0.19	0.45	0.21

ND not detected
- not determined

a FeO calculated such that Fe₂O₃/FeO = 0.2

Table 5-5 b. Trace element data^a and inter-element ratios for Sandspruit Formation Ultramafic Komatiites.

SAMPLE	87-J	88-J	VU-33	HSS-131	HSS-130	HSS-105	HSS-107	HSS-112	86-J
Nb	< 1.0	1.1	< 0.9	4.1	3.1	1.1	1.1	< 0.9	< 0.8
Zr	28.5	26.0	17.3	42.1	30.6	20.0	21.4	20.9	10.1
Y	9.8	8.4	6.5	10.1	7.6	6.8	5.6	6.0	4.0
Sr	46.4	39.1	32.4	32.1	79	13.3	11.3	26.7	1.9
Rb	0.6	0.9	1.4	1.0	1.3	0.7	0.6	0.7	7.3
Zn	56	69	59	89	112	52	55	75	46.9
Cu	263	7.1	10.8	25.5	< 1.0	< 1.0	< 1.0	9.9	< 2.0
Ni	1140	1572	2198	2533	2996	2281	2137	2083	3105
Co	90	109	120	123	151	118	115	132	114
V	150	124	94	96	100	91	82	77	51
Ba	< 2.0	9.7	4.3	< 2.0	123	< 2	< 2.0	< 2.0	3.4
Ga	6.8	5.9	5.2	4.5	5.0	3.7	3.9	3.7	2.5
Sc	-	-	-	-	-	-	-	-	-
CaO/Al ₂ O ₃	2.4	2.6	1.4	0.7	0.9	1.5	1.4	1.4	0.2
Si/Ti	53	69	105	63	71	125	114	138	153
Al/Ti	4.9	4.6	9.4	5.0	6.2	10	8.4	12	7.5
Fe/Ti	22	28	41	25	38	43	41	57	49
Mg/Ti	32	49	92	52	71	118	108	142	185
Ca/Ti	16	16	18	5.0	7.9	21	16	22	1.7
Ti/Nb	-	3057	-	886	946	1583	1727	-	-
Ti/Zr	151	127	120	86	95	88	91	71	136
Ti/Y	438	397	320	360	381	259	345	247	343
Ti/Ni	3.8	2.1	0.9	1.4	1.0	0.8	0.9	0.7	0.4
Ti/Co	48	31	17	30	19	15	17	11	12
Ti/V	29	27	22	38	29	19	24	19	27
Ti/Ga	637	566	480	800	580	480	493	401	545
Ti/Sc	-	-	-	-	-	-	-	-	-

- not determined

a data as ppm and recalculated volatile free.

Table 5-6. Average compositions for the aphyric group, porphyritic group of rocks and the average ultramafic rock from the Komati and Theespruit Formations compared to the average Sandspruit Formation rock.

	Selected average aphyric lava	Selected average porphyritic rock	Average ultramafic rock	Average Sandspruit Formation rock
n	13	10	-	9
(wt.%)				
SiO ₂	47.11	45.75	46.43	46.59
TiO ₂	0.36	0.32	0.34	0.42
Al ₂ O ₃	3.93	3.35	3.64	3.22
FeO*	11.67	10.82	11.25	11.14
MnO	0.19	0.17	0.18	0.18
MgO	28.95	33.72	31.34	32.60
CaO	6.74	4.84	5.79	4.71
Cr ₂ O ₃	0.42	0.40	0.41	0.39
(ppm)				
Zr	27.3	21.4	24.4	24.1
Y	8.2	6.2	7.2	8.1
Ni	1611	2199	1905	2227
Co	127	127	127	119
V	106	96	102	96
Ga	4.8	4.5	4.7	4.6
Sc	20.8	17.9	19.4	-
CaO/Al ₂ O ₃	1.72	1.44	1.58	1.46

* Total iron as FeO.

Table 5-7. Regression equations and X-intercept compositions for oxide/element versus MgO data for selected^a aphyric ultramafic komatiite lavas from the LUU.

	<u>Slope</u>	<u>Intercept</u>	<u>R</u>	<u>n</u>	<u>Comp. at TiO₂=0</u>	<u>Comp. at CaO=0</u>	<u>Comp. at MgO=33%</u>	<u>Comp. at MgO=24%</u>
SiO ₂	-0.2982	55.745	0.76	13	40.35	43.62	45.90	48.59
TiO ₂	-0.0160	0.826	0.89	13	0.00	0.18	0.30	0.44
Al ₂ O ₃	-0.1777	9.075	0.91	13	-0.10	1.85	3.21	4.81
FeO* ^b	-0.0589	13.187	0.19	12	10.15	10.79	11.24	11.77
MnO	-0.0030	0.279	0.37	13	0.12	0.16	0.18	0.21
MgO	-	-	-	-	51.63	40.66	33.00	24.00
CaO	-0.5759	23.417	0.97	13	-6.32	0.00	4.41	9.60
Cr ₂ O ₃	0.0196	-0.150	0.21	13	0.86	0.65	0.50	0.32
Cr ₂ O ₃ ^c	-0.0101	0.646	0.52	10	0.13	0.24	0.31	0.40
Zr	-0.7743	49.8	0.29	13	9.8	18.3	24.2	31.2
Zr ^d	-1.137	58.7	0.92	10	0.0	12.4	21.2	31.4
Y	-0.1443	12.4	0.17	13	5.0	6.6	7.6	8.9
Y ^d	-0.2013	13.9	0.37	10	3.5	5.7	7.3	9.1
Ni	89.44	-978.7	0.75	13	3639	2658	1973	1168
Co	3.643	21.7	0.65	13	210	170	142	109
V	-4.898	247.9	0.94	13	-4.9	48.8	86	130
Ga	-0.1950	10.4	0.78	13	0.4	2.5	4.0	5.7
Sc	-1.222	55.8	0.97	6	-7.3	6.1	15.5	26.5

a - HSS-88C, HSS-95, AU-5, 53-J and 49-J excluded from the regression calculations.

b - HSS-150 excluded.

c - HSS-87, HSS-109 and HSS-150 excluded.

d - HSS-523, HSS-14 and HSS-15 excluded.

Table 5-8. Regression equations and X-intercept compositions for oxide/element versus MgO data for selected^a ultramafic komatiite porphyritic rocks from the LUU.

Oxide/Element	Slope	Intercept	R	n	MgO intercept value
SiO ₂	-0.3673	58.13	0.54	10	-
TiO ₂	-0.0185	0.94	0.48	10	50.78
Al ₂ O ₃	-0.1677	9.00	0.61	10	53.71
FeO*	-0.0639	12.98	0.05	10	-
MnO	-0.0030	0.28	0.44	10	-
CaO	-0.3889	17.95	0.86	10	46.16
CaO ^b	-0.2845	13.89	0.70	8	48.82
CaO ^c	-0.3188	16.10	0.99	5	50.50
Cr ₂ O ₃	0.0002	00.40	0.00	10	-
Zr	-0.8562	50.3	0.37	10	58.71
Y	-0.1105	9.9	0.03	10	59.45
Ni	102.0	-1243	0.46	10	-
Co	1.952	62	0.20	10	-
V	-4.885	261	0.45	10	53.43
Ga	-0.2154	11.8	0.32	10	54.78
Sc	-1.513	66.8	0.95	4	44.15

a - Samples selected:- HSS-88B, HSS-535, HSS-534, HSS-536, HSS-8, HSS-13, HSS-27, HSS-31, HSS-33, HSS-28.

b - All samples in Table 5-4b with CaO/Al₂O₃ ratios in the range 1.0 - 1.3.

c - All samples in Table 5-4b with CaO/Al₂O₃ ratios in the range 1.6 - 1.9.

Table 5-9. Ultramafic rocks considered to be representative of magma compositions from other greenstone belts.

<u>Sample Numbers</u>	<u>Source of Data</u>
<u>Rhodesia</u>	
NG-213, NG-214	Bickle et al.(1975)
B-4, SF-134, NG-7622, NG-7639, NG-152, NG-7638, NG-7625, NG-7628, NG-7621	Nisbet et al. (1977)
<u>Western Australia</u>	
SD-3/266, 331/87, 331/89	Nesbitt (1971)
3	Williams (1972)
1,2	Hallberg and Williams (1972)
331/277, 331/346, 331/347, 331/144/5, 331/144/25, 331/144/42, SD-4/193	Nesbitt and Sun (1976)
106, 108, 59, 170, 171, 172	Naldrett and Turner (1977)
SD-8/507, 331/307, 331/326	Sun and Nesbitt (1978)
331/496, 331/497, 331/498, 331/531, 331/533	Nesbitt et al. (1979)
<u>Munro Township</u>	
SA-1160	Pyke et al. (1973)
P9-191, P9-168, P9-137, P9-117 P9-139	Arndt (1975)
422/91, 422/95, 422/98	Nesbitt and Sun (1976)
A ₁ M ₂ , A ₂ M ₂ , A ₁ M ₃ , A ₂ M ₃ , P9-118, P9-120, SA-2048	Arndt et al. (1977)
A1, A2	Arth et al. (1977)

Table 5-10. Regression equation data for element trends observed in ultramafic lavas from other greenstone belts.

<u>Trend</u>	<u>Slope</u>	<u>Intercept</u>	<u>R</u>	<u>n</u>	<u>MgO intercept value</u>
<u>Rhodesia</u>					
TiO ₂ -MgO	-0.01574	0.744	0.82	11	47.3
Al ₂ O ₃ -MgO	-0.2232	12.44	0.73	11	55.7
CaO-MgO	-0.2742	13.83	0.86	11	50.4
<u>Western Australia</u>					
TiO ₂ -MgO	-0.01731	0.834	0.73	27	48.2
Al ₂ O ₃ -MgO	-0.2338	12.95	0.44	27	55.4
CaO-MgO	-0.3182	15.70	0.83	27	49.3
<u>Munro Township</u>					
TiO ₂ -MgO	-0.02814	1.057	0.61	18	37.6
Al ₂ O ₃ -MgO	-0.3863	17.66	0.82	17	45.7
CaO-MgO	-0.5803	22.72	0.88	18	39.2
<u>Lower Ultramafic Unit</u>					
TiO ₂ -MgO	-0.01600	0.826	0.89	13	51.6
Al ₂ O ₃ -MgO	-0.1777	9.08	0.91	13	51.4
CaO-MgO	-0.5759	23.42	0.97	13	40.7

Table 5-11. Average inter-element ratios calculated for the aphyric ultramafic lava compositions for Belingwe, Western Australia and Munro Township greenstone belts.

	LUU (Group II)	LUU (Group I)	Belingwe	Western Australia	Munro Township
CaO/Al ₂ O ₃	1.72	1.46	1.01	1.07	1.00
Al/Ti	9.6	16.5	17.6	16.9	21.3
Ca/Ti	22.6	32.0	24.0	23.6	28.4
Ti/Zr	79	121 ^a	-	112	119
Ti/V	20.0	13.0	-	15.6	14.1

a Zr data for 49-J from Nesbitt and Sun (1976).

Table 6-1 Mineral compositions from high-and low-Mg Mafic Komatiites.

SAMPLE n	Sub-Calcic						
	Olivine HK-4 4	Pyroxene HK-4 1	Augite HSS-10 1	Clinopyroxene HK-4 5	Clinopyroxene HSS-21 4	Clinopyroxene HSS-64 2	Plagioclase HK-4 2
SiO ₂	39.59	53.90	55.87	53.97	53.53	53.44	44.24
TiO ₂	ND	-	-	ND	0.16	0.21	ND
Al ₂ O ₃	0.04	1.13	1.47	1.81	1.19	1.31	35.69
FeO*	12.41	6.89	10.12	4.64	5.20	6.47	0.34
MnO	0.18	-	-	0.13	0.16	0.16	ND
MgO	47.43	28.41	17.94	20.71	18.63	18.84	0.26
CaO	0.18	8.76	12.51	18.47	19.32	18.28	19.19
Na ₂ O	0.06	-	-	0.10	0.23	0.29	0.88
K ₂ O	ND	-	-	ND	ND	ND	0.01
Cr ₂ O ₃	0.04	0.11	0.37	0.22	0.82	0.54	0.01
NiO	0.192	0.073	0.076	0.065	0.063	-	-
TOTAL	100.12	99.27	98.36	100.39	99.30	99.53	100.62
100 Mg/(Mg+Fe)	87.2	88.0	76.0	88.8	86.5	83.9	-
RANGE	87.8	-	-	89.1	87.5	86.8	-
	86.8	-	-	88.5	85.3	80.9	-
Ab	-	-	-	-	-	-	7.6
An	-	-	-	-	-	-	92.4
Or	-	-	-	-	-	-	0.04

ND not detected

- not determined

FeO* total Fe expressed as FeO.

Table 6-2a Major element and normative mineral data for aphyric high-Mg Mafic Komatiites.

SAMPLE	42-J	HSS-62	K-178	SG-80	KJ-39
SiO ₂	53.76	52.58	53.44	50.02	51.13
TiO ₂	0.38	0.29	0.34	0.60	0.38
Al ₂ O ₃	8.26	8.65	4.03	7.37	6.49
Fe ₂ O ₃	1.24	1.40	1.47	1.81	1.47
FeO ^a	6.22	7.01	7.35	9.07	7.37
MnO	0.14	0.15	0.16	0.17	0.18
MgO	20.40	20.78	22.22	22.39	22.92
CaO	6.69	7.40	10.60	7.93	9.17
Na ₂ O	2.25	1.17	0.04	0.10	0.53
K ₂ O	0.04	0.03	0.01	0.04	0.11
P ₂ O ₅	-	0.01	0.06	-	-
S	0.03	0.01	0.07	0.03	0.10
Cr ₂ O ₃	0.44	0.40	-	0.32	-
NiO	0.14	0.12	0.20	0.15	0.15
TOTAL	100.00	100.00	100.00	100.00	100.00
LOI ₋	-	4.46	-	-	-
H ₂ O ₊	0.14	0.33	0.56	0.29	0.12
H ₂ O	4.96	-	3.74	5.89	4.86
CO ₂	0.10	-	-	0.02	0.07
ORIG. TOTAL	99.29	100.01	98.43	99.67	99.54
NORMS					
QZ	-	-	0.88	-	-
OR	0.24	0.18	0.06	0.24	0.65
PL	31.36	28.16	11.13	20.39	19.49
DI	16.55	14.61	32.91	15.78	24.21
HY	38.22	47.99	51.95	50.83	39.88
OL	10.39	5.84	-	8.47	12.70
MT	1.80	2.03	2.13	2.62	2.13
CM	0.65	0.59	-	0.47	-
IL	0.72	0.55	0.65	1.14	0.72
AP	-	0.02	0.14	-	-
PY	0.06	0.02	0.13	0.06	0.19
T ^o _c	1425	1432	1460	1463	1473
z (poises)	13.2	10.4	6.7	6.1	6.7
P	2.863	2.900	2.941	2.987	2.949

- not determined

a FeO calculated such that Fe₂O₃/FeO = 0.2.

Table 6-2b. Trace element data^a and inter-element ratios of aphyric high-Mg Mafic Komatiites.

SAMPLE	42-J	HSS-62	K-178	SG-80	KJ-39
Nb	< 0.9	< 2	1.1	1.2	< 0.9
Zr	31.9	13.8	24.6	32.0	23.2
Y	8.8	6.1	7.5	9.5	8.6
Sr	14.9	12.7	17.1	10.9	7.9
Rb	< 0.4	< 2	0.7	0.6	0.8
Zn	49	77	89	77	71
Cu	1.9	75	77	41	13.7
Ni	1127	963	1582	1181	1162
Co	92	89	85	113	103
V	155	154	94	169	112
Ba	8.3	6.7	21.4	6.2	15.6
Ga	6.9	7.5	5.0	8.1	5.5
Sc	-	31.5	-	27.8	-
CaO/Al ₂ O ₃	0.81	0.86	2.63	1.08	1.41
Si/Ti	110	141	123	65	105
Al/Ti	19.1	26.0	10.4	10.9	15.1
Fe/Ti	25	37	33	23	30
Mg/Ti	54	72	66	38	61
Ca/Ti	20.9	30.1	37.0	15.8	28.8
Ti/Zr	72	128	83	112	98
Ti/Y	260	286	274	377	266
Ti/Ni	2.0	1.8	1.3	3.0	2.0
Ti/Co	27.7	19.8	26.6	34.3	24.5
Ti/V	15	12	22	21	20
Ti/Ga	332	232	408	442	415
Ti/Sc	-	55	-	129	-
Al/V	282	297	227	231	307
Ga/Alx10 ⁵	15.8	16.4	23.4	21	16.0
Zr/Nb	-	-	23	27	-
Zr/Y	3.6	2.2	3.3	3.4	2.7

- not determined

a data as ppm and recalculated volatile free.

Table 6-3a. Major element and normative mineral data for porphyritic high-Mg Mafic Komatiites.

SAMPLE	HSS-12	HSS-9	HSS-10	HSS-54
SiO ₂	51.26	48.97	48.71	45.94
TiO ₂	0.51	0.51	0.47	0.73
Al ₂ O ₃	5.53	5.41	6.53	6.44
Fe ₂ O ₃	1.97	2.17	2.19	2.18
FeO ^a	9.85	10.87	10.95	10.88
MnO	0.19	0.17	0.21	0.14
MgO	19.94	20.61	21.78	25.06
CaO	10.25	10.43	8.40	7.71
Na ₂ O	0.03	0.32	0.17	0.06
K ₂ O	0.02	0.03	0.03	0.03
P ₂ O ₅	0.04	0.05	0.06	0.05
S	0.03	0.08	0.04	0.04
Cr ₂ O ₃	0.28	0.25	0.37	0.49
NiO	0.09	0.14	0.10	0.25
TOTAL	100.00	100.00	100.00	100.00
LOI	3.61	3.98	5.18	6.43
H ₂ O ₊	0.27	0.25	0.42	0.27
H ₂ O ⁻	-	-	-	-
CO ₂	-	-	-	-
ORIG. TOTAL	99.20	100.25	99.87	100.32
NORMS				
QZ	-	-	-	-
OR	0.12	0.18	0.18	0.18
PL	15.15	15.94	18.40	17.72
DI	28.57	30.61	19.47	16.53
HY	51.60	34.02	43.11	30.82
OL	0.16	14.48	14.00	29.28
MT	2.86	3.15	3.18	3.16
CM	0.41	0.37	0.54	0.72
IL	0.97	0.97	0.89	1.39
AP	0.09	0.12	0.14	0.12
PY	0.06	0.15	0.07	0.07

- not determined

a FeO calculated such that Fe₂O₃/FeO = 0.2

Table 6-3b. Trace element data^a and inter-element ratios for porphyritic high-Mg Mafic Komatiites.

SAMPLE	HSS-12	HSS-10	HSS-54	HSS-9
Nb	< 1.0	1.6	3.4	2.2
Zr	31.8	35.4	44.0	39.0
Y	11.7	11.8	11.1	11.6
Sr	37.1	37.6	11.0	17.9
Rb	1.0	1.3	0.7	0.6
Zn	81	91	80	92
Cu	57	51	116	109
Ni	722	761	1937	1089
Co	106	112	117	111
V	140	146	165	150
Ba	< 2.0	< 2.0	4.5	7.4
Ga	5.5	7.3	8.9	7.2
Sc	30.9	-	24.3	26.6
CaO/Al ₂ O ₃	1.85	1.29	1.20	1.93
Si/Ti	78	81	49	75
Al/Ti	9.5	12.2	7.8	9.4
Fe/Ti	29.6	35.6	22.8	32.6
Mg/Ti	39	47	35	41
Ca/Ti	23.8	21.2	12.6	24.6
Ti/Zr	97	80	100	78
Ti/Y	264	240	397	262
Ti/Ni	4.3	3.7	2.3	2.8
Ti/Co	29.1	25.4	37.5	30.0
Ti/V	22.0	19.4	26.6	20.3
Ti/Ga	559	388	493	423
Ti/Sc	99	-	180	115
Al/V ⁵	209	237	207	191
Ga/Alx10	18.8	21.1	26.1	25.1
Zr/Nb	-	22	13	18
Zr/Y	2.7	3.0	4.0	3.4

- not determined

a data as ppm and recalculated volatile free.

Table 6-4a. Major element and normative mineral data for aphyric low-Mg Mafic Komatiites.

SAMPLE	PILLOWS(5)	TS-1	HSS-73	HSS-21	HSS-91	HSS-25	SD-42C	HSS-65	HSS-82
SiO ₂	53.85	54.93	52.11	56.66	53.37	54.81	57.25	56.38	53.56
TiO ₂	0.78	0.76	0.96	0.77	0.77	0.83	0.56	0.77	0.81
Al ₂ O ₃	11.54	12.08	11.64	9.24	11.46	9.66	7.85	9.29	9.86
Fe ₂ O ₃	1.83	1.61	1.92	1.66	1.81	1.85	1.78	1.55	1.95
FeO ^a	9.13	8.05	9.61	8.31	9.03	9.23	8.89	7.74	9.73
MnO	0.18	0.17	0.18	0.18	0.19	0.19	0.18	0.13	0.21
MgO	9.18	9.18	9.81	10.00	10.12	10.34	10.38	10.74	11.30
CaO	10.38	9.48	9.94	9.67	10.03	11.47	9.97	9.70	9.69
Na ₂ O	2.67	3.31	3.42	2.98	2.81	1.10	2.71	3.44	2.47
K ₂ O	0.26	0.15	0.06	0.23	0.18	0.31	0.14	0.04	0.21
P ₂ O ₅	0.10	6.12	0.12	0.08	0.10	0.08	0.07	0.06	0.07
S	0.03	0.04	0.03	0.06	0.03	0.03	0.03	0.01	0.01
Cr ₂ O ₃	0.10	0.10	0.16	0.11	0.09	0.09	0.15	0.11	0.11
NiO	0.02	0.03	0.04	0.03	0.03	0.02	0.03	0.02	0.02
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOI ₋	0.81	1.19	5.25	1.97	1.06	2.13	2.35	2.97	2.54
H ₂ O ₋	0.05	-	0.21	0.09	0.02	0.08	0.04	0.10	0.24
H ₂ O ₊	1.95	-	-	-	2.06	-	-	2.50	3.54
CO ₂	0.23	-	-	-	0.22	-	-	1.53	0.54
ORIG. TOTAL	100.46	99.78	99.49	99.15	100.32	98.44	100.90	98.39	99.86
OZ	2.14	1.97	-	5.06	0.32	8.70	6.55	2.40	1.05
OR	1.51	0.89	0.35	1.36	1.06	1.83	0.83	0.24	1.24
PL	41.33	45.67	45.17	36.37	41.90	29.81	31.77	38.90	36.10
DI	26.14	23.20	26.29	29.41	25.16	29.13	32.60	30.62	26.31
HY	24.31	24.00	14.17	23.44	27.06	25.90	24.15	23.80	30.60
OL	-	-	8.83	-	-	-	-	-	-
MT	2.65	2.33	2.78	2.41	2.62	2.68	2.58	2.25	2.83
CM	0.14	0.15	0.24	0.16	0.13	0.13	0.22	0.16	0.16
IL	1.48	1.44	1.82	1.46	1.46	1.58	1.06	1.46	1.54
AP	0.24	0.28	0.28	0.19	0.24	0.19	0.17	0.14	0.17
PY	0.07	0.07	0.06	0.11	0.06	0.06	0.06	0.02	0.02
T ^o c	1215	1214	1226	1230	1232	1236	1237	1244	1254
Z (poises)	424	565	202	242	209	-	-	238	159
p	2.921	2.876	2.930	2.872	2.914	-	-	2.865	2.945

ND not detected
- not determined

a FeO calculated such that Fe₂O₃/FeO = 0.2

Table 6-4a. (Cont.)

SAMPLE	HSS-84	SC-6B	HSS-81	HSS-154	HSS-70	HSS-7	HSS-C1	SC-6A	HSS-C3
SiO ₂	53.65	52.71	50.09	50.65	53.71	55.13	52.32	53.12	53.09
TiO ₂	0.79	0.76	0.77	0.87	0.59	0.65	0.66	0.60	0.54
Al ₂ O ₃	9.76	7.99	9.42	9.57	7.40	7.36	6.77	6.53	5.82
Fe ₂ O ₃	1.94	2.28	2.16	2.19	1.91	1.65	1.97	2.02	1.97
FeO	9.70	11.38	10.79	10.96	9.55	8.24	9.84	10.08	9.84
MnO	0.20	0.19	0.23	0.22	0.20	0.18	0.24	0.22	0.19
MgO	11.55	11.98	12.28	12.28	13.21	13.44	14.29	14.59	16.27
CaO	9.56	10.54	12.64	12.42	10.87	11.29	12.04	11.04	10.58
Na ₂ O	2.44	1.90	1.31	0.45	2.19	1.71	1.45	1.43	1.34
K ₂ O	0.21	0.08	0.08	0.16	0.02	0.06	0.08	0.04	0.06
P ₂ O ₅	0.07	0.07	0.07	0.05	0.05	0.07	0.07	0.06	0.04
S	0.01	0.01	0.01	ND	ND	0.01	ND	0.01	0.01
Cr ₂ O ₃	0.11	0.10	0.12	0.12	0.25	0.20	0.22	0.20	0.19
NiO	0.03	0.03	0.03	0.03	0.04	0.03	0.06	0.05	0.06
TOTAL	100.00	100.00	100.00	99.99	100.00	100.00	100.00	100.00	100.00
LOI	2.39	1.21	3.24	1.38	3.91	2.30	1.52	1.57	2.24
H ₂ O ₋	ND	0.07	0.25	0.05	0.12	0.22	0.09	0.03	0.22
H ₂ O ₊	3.08	2.82	-	-	-	-	2.56	2.86	3.15
CO ₂	0.50	0.23	-	-	-	-	0.25	0.15	0.15
ORIG. TOTAL	99.30	99.10	99.19	100.89	99.70	99.78	100.50	100.58	101.23
QZ	1.11	1.26	-	2.92	0.47	4.41	-	1.37	0.24
OR	1.24	0.47	0.47	0.95	0.12	0.35	0.47	0.24	0.35
PL	35.70	29.11	30.67	27.43	28.86	26.70	24.00	23.38	21.03
DI	25.88	31.59	34.65	30.60	34.96	34.84	38.36	34.78	34.22
HY	31.43	32.51	24.98	32.97	31.24	29.61	32.00	35.70	39.89
OL	-	-	4.27	-	-	-	0.59	-	-
MT	2.81	3.31	3.13	3.18	2.77	2.39	2.86	2.93	2.86
CM	0.16	0.15	0.18	0.18	0.37	0.29	0.32	0.29	0.28
IL	1.50	1.44	1.46	1.65	1.12	1.23	1.25	1.14	1.03
AP	0.17	0.17	0.17	0.12	0.12	0.17	0.17	0.14	0.09
PY	0.02	0.02	0.02	-	-	0.02	-	0.02	0.02
T ^o c	1259	1267	1273	1273	1290	1294	1311	1316	1348
Z (poises)	156	105	84.2	82.6	57.9	63.4	-	42.6	22.4
p	2.945	3.008	3.031	3.036	2.953	2.921	-	2.989	2.979

Table 6-4b. Trace element data^a and inter-element ratios for aphyric low-Mg Mafic Komatiites.

SAMPLE	PILLOWS(5)	TS-1	HSS-73	HSS-21	HSS-91	HSS-25	SD-42C	HSS-65	HSS-82
Nb	3.3	3.5	2.3	3.3	3.8	2.8	2.5	2.4	< 2.0
Zr	66	65	40.8	61	65	67	39.0	59	62
Y	18.2	16.4	12.2	17.7	19.0	20.0	11.3	16.5	18.7
Sr	153	136	55	75	148	81	48.2	59	67
Rb	6.4	2.2	2.8	3.9	3.1	5.0	1.3	< 2.0	< 2.0
Zn	98	83	105	90	77	88	95	109	115
Cu	144	132	120	88	122	125	142	157	125
Ni	189	225	277	207	197	185	263	188	185
Co	61	64	68	62	59	64	65	59	68
Cr	649	648	1103	754	615	626	1059	775	757
V	201	196	255	185	199	199	162	202	213
Ba	36.4	20.4	17.4	19.8	30.5	16.8	57	25.4	20.8
Ga	11.3	10.1	11.3	10.2	10.2	9.8	8.8	9.3	10.3
Sc	29.0	28.3	31.8	33.0	-	-	30.1	35.8	-
CaC/Al ₂ O ₃	0.90	0.78	0.85	1.05	0.88	1.19	1.27	1.04	0.98
Si/Ti	54	56	42	57	54	51	80	57	52
Al/Ti	13.1	14.0	10.7	10.6	13.1	10.3	12.4	10.7	10.7
Fe/Ti	17.9	16.2	15.3	16.5	17.9	17.0	24.3	15.4	18.4
Mg/Ti	11.8	12.2	10.3	13.1	13.2	12.5	18.6	14.0	14.0
Ca/Ti	15.9	14.9	12.3	15.0	15.5	16.5	21.2	15.0	14.3
Ti/Zr	71	70	141	76	71	74	86	78	78
Ti/Y	257	278	472	261	243	249	297	280	260
Ti/Ni	25	20	21	22	23	27	13	25	26
Ti/Co	77	71	85	74	78	78	52	78	71
Ti/V	23	23	23	25	23	25	21	23	23
Ti/Ga	414	451	509	453	453	508	382	496	471
Ti/Sc	161	161	181	140	-	-	112	129	-
Al/V	304	326	242	264	305	257	256	243	245
Ga/Alx10 ⁵	18.5	15.8	18.3	20.9	16.8	19.2	21.2	18.9	19.7
Zr/Nb	20	18.6	17.7	18.5	17.1	23.9	15.6	24.6	-
Zr/Y	3.6	4.0	3.3	3.4	3.4	3.4	3.5	3.6	3.3

- not determined

a data as ppm and recalculated volatile free.

Table 6-4b. (Cont.)

SAMPLE	HSS-84	SC-6B	HSS-81	HSS-154	HSS-70	HSS-7	HSS-C1	SC-6A	HSS-C3
Nb	< 2.0	3.7	< 2.0	4.2	< 2.0	2.5	3.5	2.2	2.3
Zr	62	60	62	64	49.7	47.7	51	46.0	43.0
Y	17.7	17.6	21.2	19.8	13.5	14.5	15.8	13.3	12.6
Sr	149	62	133	35.6	31.7	33.2	45.0	74	53
Rb	< 2.0	1.2	< 2.0	1.7	< 2.0	1.4	< 1.0	0.8	1.9
Zn	113	202	125	118	112	72	132	117	85
Cu	86	245	100	< 2.0	155	31.1	109	40.0	77
Ni	208	202	240	228	290	241	453	412	492
Co	64	76	72	77	78	59	78	80	83
Cr	756	669	789	848	1742	1377	1483	1384	1316
V	212	215	220	235	167	170	186	161	154
Ba	51	32.1	13.9	42.7	15.8	17.6	35.8	56	23.5
Ga	10.7	10.0	12.4	11.1	7.8	8.1	7.6	8.3	7.2
Sc	-	39.9	-	-	29.7	36.0	33.5	31.1	27.4
CaO/Al ₂ O ₃	0.98	1.32	1.34	1.30	1.47	1.53	1.78	1.69	1.82
Si/Ti	53	54	51	45	71	66	62	69	77
Al/Ti	10.9	9.3	10.8	9.7	11.1	10.0	9.1	9.6	9.5
Fe/Ti	18.8	22.9	21.4	19.3	24.8	19.4	22.8	25.7	27.9
Mg/Ti	14.7	15.9	16.0	14.2	22.5	20.8	21.8	24.5	30.3
Ca/Ti	14.4	16.5	19.6	17.0	22.0	20.7	21.7	21.9	23.4
Ti/Zr	76	76	74	81	71	82	78	78	75
Ti/Y	268	259	218	263	262	269	250	270	257
Ti/Ni	23	23	19	23	12	16	8.7	8.7	6.6
Ti/Co	74	60	64	68	45	66	51	45	39
Ti/V	22	21	21	22	21	23	21	22	21
Ti/Ga	443	456	372	470	453	481	521	433	450
Ti/Sc	-	114	-	-	119	108	118	116	118
Al/V	244	197	227	216	235	229	193	215	200
Ga/Alx10 ⁵	20.7	23.6	24.9	21.9	19.9	20.8	21.2	24.0	23.4
Zr/Nb	-	16.2	-	15.2	-	19.1	14.6	20.9	18.7
Zr/Y	3.5	3.4	2.9	3.2	3.7	3.3	3.2	3.5	3.4

Table 6-5a. Major element and normative mineral data for porphyritic low-Mg Mafic Komatiites.

SAMPLE	HSS-16	HSS-517	SC-12	HSS-64	AB-9	HSS-20	HSS-34	526	KJ-55	HSS-157	LV-6	M-57
SiO ₂	49.91	54.02	56.73	55.37	53.42	53.77	54.77	53.75	56.16	54.51	52.48	52.57
TiO ₂	1.27	0.93	0.60	0.82	0.73	0.63	0.62	0.74	0.48	0.54	1.10	0.56
Al ₂ O ₃	10.90	8.56	6.38	8.89	8.80	8.11	9.79	10.10	10.66	7.97	9.94	6.41
Fe ₂ O ₃	2.46	1.98	1.73	1.71	1.87	1.82	1.67	1.57	1.76	1.72	1.92	2.13
FeO ^a	12.32	9.92	8.63	8.55	9.33	9.09	8.34	7.87	8.78	8.58	9.59	10.67
MnO	0.24	0.21	0.21	0.17	0.23	0.17	0.15	0.21	0.17	0.19	0.18	0.26
MgO	9.26	10.26	11.50	11.51	11.64	11.77	12.02	12.26	12.35	13.07	13.11	13.33
CaO	10.95	11.89	11.16	9.81	10.83	11.80	9.43	10.29	7.74	11.16	8.99	12.24
Na ₂ O	2.17	1.85	2.78	2.91	2.93	2.53	2.91	2.96	1.54	1.90	2.21	1.61
K ₂ O	0.23	0.13	0.02	0.05	0.06	0.04	0.05	0.16	0.11	0.08	0.32	0.05
P ₂ O ₅	0.09	0.10	0.06	0.07	0.07	0.07	0.05	-	0.06	0.05	-	0.08
S	0.12	0.01	0.01	ND	0.05	0.02	0.06	0.03	0.06	ND	0.06	0.05
Cr ₂ O ₃	0.04	0.10	0.17	0.12	-	0.17	0.13	-	0.11	0.20	-	-
NiO	0.04	0.04	0.03	0.03	0.03	0.02	0.03	0.06	0.03	0.03	0.10	0.04
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	100.00
LOI ₋	2.93	1.24	0.61	2.93	-	1.11	2.31	-	3.19	1.20	-	1.76
H ₂ O ₊	0.11	0.08	0.06	0.14	0.25	0.08	0.15	0.07	-	0.08	0.11	-
H ₂ O	-	-	-	2.82	1.69	-	-	2.37	-	-	3.81	-
CO ₂	-	-	-	1.10	0.14	-	-	0.03	-	-	0.14	-
ORIG. TOTAL	99.41	100.82	100.06	100.64	100.13	100.35	99.05	99.70	98.93	101.55	99.63	99.55
NORMS												
QZ	-	4.69	4.18	2.29	-	-	0.86	-	9.06	2.75	-	0.05
OR	1.30	0.77	0.12	0.30	0.35	0.24	0.30	0.95	0.65	0.47	1.89	0.30
PL	36.90	30.32	28.39	35.67	35.48	32.06	38.13	38.85	34.88	29.06	34.96	23.74
DI	27.89	35.54	40.52	30.02	34.50	38.37	26.58	29.99	13.05	33.89	22.88	40.60
HY	17.76	23.64	22.75	27.36	20.72	25.03	30.12	21.32	38.48	29.90	32.85	30.87
OL	9.82	-	-	-	4.57	0.01	-	5.15	-	-	2.43	-
MT	3.49	2.87	2.51	2.48	2.71	2.64	2.42	2.28	2.55	2.49	2.78	3.09
CM	0.06	0.15	0.25	0.18	-	0.25	0.19	-	0.16	0.29	-	-
IL	2.37	1.77	1.14	1.56	1.39	1.20	1.18	1.41	0.91	1.03	2.09	1.06
AP	0.21	0.24	0.14	0.17	0.17	0.17	0.12	-	0.14	0.12	-	0.19
PY	0.21	0.02	0.02	-	0.09	0.04	0.11	0.06	0.11	-	0.11	0.09

ND not detected
- not determined

a FeO calculated such that Fe₂O₃/FeO = 0.2

Table 6-5a. (Cont.)

SAMPLE	HSS-6	HSS-32	R-14	HSS-C2	SD-42A	HSS-77	HSS-78	VB-2	HSS-51	HSS-332	SC-6C
SiO ₂	52.80	51.65	54.20	54.74	52.97	49.84	50.87	51.36	49.62	50.50	50.03
TiO ₂	0.39	1.10	0.36	0.51	0.63	0.86	0.54	0.68	0.72	0.57	0.55
Al ₂ O ₃	7.52	8.16	4.54	4.88	8.60	8.54	7.43	5.32	8.49	6.58	6.27
Fe ₂ O ₃	1.46	1.91	1.53	1.76	1.83	2.10	2.08	1.86	2.15	2.28	2.06
FeO	7.30	9.55	7.63	8.82	9.16	10.52	10.38	9.32	10.75	11.41	10.28
MnO	0.17	0.19	0.20	0.23	0.20	0.22	0.23	0.29	0.21	0.21	0.20
MgO	14.72	14.74	15.14	15.18	15.41	15.53	15.71	15.76	15.91	16.74	18.74
CaO	12.35	10.38	14.52	12.06	9.23	10.30	11.57	13.34	10.18	10.43	10.90
Na ₂ O _i	2.52	1.47	1.49	1.45	1.51	1.55	0.76	1.62	1.30	0.68	0.47
K ₂ O	0.49	0.33	0.04	0.05	0.06	0.14	0.07	0.06	0.08	0.02	0.03
P ₂ O ₅	0.03	0.12	0.04	0.03	0.07	0.06	0.04	0.07	0.08	0.04	0.06
S	0.03	0.03	0.01	ND	0.04	ND	0.01	0.05	0.05	0.02	0.02
Cr ₂ O ₃	0.18	0.26	0.28	0.26	0.22	0.27	0.28	0.24	0.38	0.41	0.28
NiO	0.04	0.10	0.03	0.04	0.05	0.09	0.05	0.03	0.09	0.12	0.10
TOTAL	100.00	100.00	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOI	2.52	2.91	1.00	1.51	2.96	4.07	3.23	-	3.21	3.12	3.05
H ₂ O ₊	0.19	0.28	0.07	0.15	0.09	0.23	0.18	0.09	0.02	0.18	0.06
H ₂ O _i	-	-	-	3.15	-	-	-	1.78	-	-	4.35
CO ₂	-	-	-	0.44	-	-	-	0.23	-	-	0.17
ORIG. TOTAL	100.19	99.42	100.15	101.16	98.67	99.76	99.97	99.52	99.93	100.22	100.48
NORMS											
QZ	-	-	0.50	2.72	1.05	-	-	-	-	-	-
OR	2.90	1.95	0.24	0.30	0.35	0.83	0.41	0.35	0.47	0.12	0.18
PL	29.08	27.13	18.19	18.93	29.29	29.05	23.09	20.78	28.09	20.60	18.89
DI	42.68	28.98	53.02	42.57	23.16	28.04	32.64	47.14	26.51	29.56	31.11
HY	7.11	34.26	24.64	31.53	41.71	24.51	37.29	16.28	28.83	41.59	37.25
OL	14.97	2.09	-	-	-	12.38	2.02	10.85	10.76	3.01	7.93
MT	2.12	2.77	2.22	2.55	2.65	3.04	3.02	2.70	3.12	3.31	2.99
CM	0.27	0.38	0.41	0.38	0.32	0.40	0.41	0.35	0.56	0.60	0.41
IL	0.74	2.09	0.68	0.97	1.20	1.63	1.03	1.29	1.37	1.08	1.04
AP	0.07	0.28	0.09	0.07	0.17	0.14	0.09	0.17	0.19	0.09	0.14
PY	0.06	0.06	0.02	-	0.07	-	0.02	0.09	0.09	0.04	0.04

Table 6-5b. Trace element data^a and inter-element ratios for porphyritic low-Mg Mafic Komatiites.

SAMPLE	HSS-16	HSS-517	SC-12	HSS-64	AB-9	HSS-20	HSS-34	526	KJ-55	HSS-157	LV-6	M-57
Nb	<2.0	5.2	3.0	3.5	2.7	2.9	<1.0	6.0	2.1	1.5	7.4	2.4
Zr	81	80	46.7	60	49.9	47.9	29.3	42.1	53	35.3	135	38.3
Y	26.2	21.3	13.2	18.9	15.3	15.3	10.9	8.1	11.6	13.1	19.2	13.4
Sr	116	149	89	51	38.7	40.8	79	47.2	74	34.2	195	43.4
Rb	2.8	1.7	0.5	0.9	0.6	0.6	0.6	< 2.0	2.8	1.4	5.9	2.8
Zn	101	125	61	160	88	78	65	59	80	68	92	108
Cu	396	219	104	90	141	116	64	57	40	< 2.0	133	124
Ni	358	302	210	224	249	162	232	507	209	209	772	307
Co	89	70	61	65	69	63	68	64	69	70	80	81
Cr	258	728	1133	841	-	1136	888	-	762	1392	-	-
V	330	180	162	214	200	204	238	207	188	217	172	174
Ba	57	117	70	18.6	7.5	5.0	11.8	24.6	26	10.8	138	19.3
Ga	17.0	10.9	7.0	10.5	8.6	8.9	10.3	-	9.9	9.3	15.4	9.8
Sc	-	-	-	-	36.6	-	-	-	-	-	25.1	-
CaO/Al ₂ O ₃	1.01	1.39	1.75	1.10	1.23	1.45	0.96	1.02	0.73	1.40	0.90	1.91
Si/Ti	30	45.3	74	53	57	67	69	57	91	79	37	73
Al/Ti	7.5	8.1	9.4	9.6	10.6	11.4	13.9	12.0	19.6	13.0	8.0	10.1
Fe/Ti	14.8	16.3	22.0	16.0	19.6	22.1	20.6	16.3	28.0	24.3	13.3	29.1
Mg/Ti	7.3	11.1	19.3	14.1	16.0	18.8	19.5	16.7	25.9	24.4	12.0	23.9
Ca/Ti	10.2	15.2	22.2	14.3	17.7	22.3	18.1	16.6	19.2	24.6	9.7	26.1
Ti/Zr	95	70	77	82	88	79	127	105	54	92	49	88
Ti/Y	292	262	273	260	286	247	341	548	248	247	343	251
Ti/Ni	21	18	17	22	18	23	16	8.8	14	15	8.5	11
Ti/Co	86	80	59	76	63	60	55	69	42	46	82	41
Ti/V	23.2	31.0	22.2	23.0	21.9	18.5	15.6	21.4	15.3	14.9	38.3	19.3
Ti/Ga	449	512	514	468	509	424	361	-	291	348	428	343
Ti/Sc	-	-	-	-	120	-	-	-	-	-	263	-
Al/V	175	252	208	220	233	210	218	258	300	194	306	195
Ga/Alx10 ⁵	29.6	24.1	20.7	22.3	18.5	20.7	19.9	-	17.5	22.0	29.3	28.9
Zr/Nb	-	15.4	15.6	17.1	18.5	16.5	-	7.0	-	25.2	18.2	16.0
Zr/Y	3.1	3.8	3.5	3.2	3.3	3.1	2.7	5.2	-	4.6	7.0	2.9

- not determined

^a data as ppm and recalculated volatile free.

Table 6-5b. (Cont.)

SAMPLE	HSS-6	HSS-32	R-14	HSS-C2	SD-42A	HSS-77	HSS-78	VB-2	HSS-51	HSS-332	SC-6C.
Nb	<1.0	3.7	1.0	2.4	1.9	< 2.0	< 2.0	1.8	1.6	<2.0	2.2
Zr	19.7	101	26.5	37.6	48.6	57	38.8	37.9	45.8	38.7	42.6
Y	10.9	18.9	11.2	12.2	14.8	18.7	12.8	12.3	15.6	16.7	13.5
Sr	54	49.4	42.8	34.5	24.3	101	18.4	56	71	16.7	20.8
Rb	8.2	6.0	0.8	< 1.0	1.4	< 2.0	< 2.0	1.2	1.8	< 2.0	1.0
Zn	69	83	65	119	132	101	91	78	80	110	98
Cu	69	192	22.4	103	222	181	79	72	93	136	58
Ni	332	750	243	299	360	686	354	241	696	931	752
Co	61	79	65	66	83	98	92	79	100	115	97
Cr	1217	1790	1943	1813	1518	1857	1914	1666	2616	2802	1948
V	193	225	151	150	179	243	183	175	235	181	159
Ba	87	91	7.6	17.5	28.5	28.6	21.5	24.6	37.5	36.6	7.3
Ga	7.5	13.3	5.2	6.1	10.0	11.7	8.2	6.9	10.5	8.2	7.2
Sc	-	-	34.8	32.0	-	-	-	-	37.1	-	28.8
CaO/Al ₂ O ₃	1.64	1.27	3.20	2.47	1.07	1.21	1.56	2.51	1.20	1.59	1.74
Si/Ti	106	37	117	84	66	45	73	59	54	69	71
Al/Ti	17.0	6.5	11.1	8.4	12.1	8.8	12.1	6.9	10.4	10.2	10.1
Fe/Ti	28.6	13.3	32.4	26.5	22.2	18.71	29.4	21.0	22.8	30.6	28.6
Mg/Ti	38.0	13.5	42.3	29.9	24.6	18.2	29.3	23.3	22.2	29.5	34.3
Ca/Ti	37.8	11.2	48.1	28.2	17.5	14.3	25.5	23.4	16.9	21.8	23.6
Ti/Zr	119	65	81	81	78	90	83	108	94	88	77
Ti/Y	215	349	193	251	255	276	253	331	277	205	244
Ti/Ni	7.0	8.8	8.9	10	10	7.5	9.1	17	6.2	3.7	4.4
Ti/Co	38	83	33	46	46	53	35	52	43	30	34
Ti/V	12.1	29.3	14.3	20.4	21.1	21.2	17.7	23.3	18.4	18.9	20.7
Ti/Ga	311	496	415	501	378	441	395	591	411	417	458
Ti/Sc	-	-	62	96	-	-	-	-	116	-	114
Al/V	206	192	159	172	254	186	215	161	191	192	209
Ga/Alx10 ⁵	18.8	30.8	21.6	23.6	22.0	25.9	20.9	24.5	23.4	23.5	21.7
Zr/Nb	-	27.3	26.5	15.7	25.6	-	-	21.1	28.6	-	19.4
Zr/Y	1.8	5.3	2.4	3.1	3.3	3.0	3.0	3.1	2.9	2.3	3.2

Table 6-6a. Major element and normative mineral data for texturally altered Mafic Komatiites.

SAMPLE	HSS-96	HSS-108	HSS-117	AB-21	HSS-38	HSS-118	HSS-122	HSS-148	KJ-40	SG-3
SiO ₂	51.65	53.61	53.43	48.18	50.90	51.86	52.20	54.04	52.00	49.12
TiO ₂	0.87	0.81	0.65	1.48	0.90	0.52	0.72	0.42	0.50	0.40
Al ₂ O ₃	10.66	10.41	9.63	9.35	9.19	8.10	4.14	3.75	9.10	7.23
Fe ₂ O ₃	2.16	1.76	1.89	2.72	2.09	1.93	2.44	1.72	1.81	2.07
FeO ^a	10.81	8.81	9.47	13.58	10.45	9.63	12.18	8.58	9.04	10.34
MnO	0.22	0.17	0.21	0.28	0.19	0.21	0.29	0.20	0.23	0.27
MgO	9.62	9.97	10.96	11.20	11.27	13.60	13.67	15.57	16.53	20.80
CaO	10.99	11.49	11.27	11.15	12.46	12.39	13.20	14.36	9.48	9.13
Na ₂ O	2.46	2.38	1.89	1.73	1.71	0.79	0.70	0.60	1.11	0.29
K ₂ O	0.39	0.37	0.41	0.11	0.56	0.62	0.33	0.04	0.03	0.03
P ₂ O ₅	0.06	0.06	0.04	0.10	0.05	0.03	0.03	0.03	0.08	0.07
S	0.02	0.01	ND	0.04	0.07	ND	0.02	0.04	0.02	0.08
Cr ₂ O ₃	0.06	0.11	0.12	-	0.11	0.26	0.04	0.26	-	-
NiO	0.02	0.02	0.02	0.07	0.03	0.06	0.05	0.04	0.06	0.18
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOI ₋	0.96	0.85	0.85	-	1.17	1.37	0.80	1.69	2.77	3.80
H ₂ O ₊	0.14	0.10	0.06	0.23	0.16	0.11	0.06	0.21	-	-
H ₂ O ₋	-	-	-	2.35	-	-	-	-	-	-
CO ₂	-	-	-	0.25	-	-	-	-	-	-
ORIG. TOTAL	100.24	100.34	100.90	99.19	100.08	100.77	100.38	100.36	100.04	99.28
NORMS										
QZ	-	1.47	2.05	-	-	0.71	1.87	4.33	-	-
OR	2.30	2.19	2.42	0.65	3.31	3.66	1.95	0.24	0.18	0.18
PL	37.71	36.77	32.57	32.06	30.22	23.44	13.10	12.50	29.15	20.79
DI	30.46	32.46	31.72	30.52	37.18	35.96	47.25	51.06	21.47	21.24
HY	20.23	22.69	26.99	18.69	18.73	32.00	30.77	28.06	44.75	40.44
OL	4.23	-	-	11.00	5.38	-	-	-	0.64	13.27
MT	3.13	2.55	2.74	3.94	3.03	2.80	3.54	2.49	2.62	3.00
CM	0.09	0.16	0.18	-	0.16	0.38	0.06	0.38	-	-
IL	1.65	1.54	1.23	2.81	1.71	0.99	1.37	0.80	0.95	0.76
AP	0.14	0.14	0.09	0.24	0.12	0.07	0.07	0.07	0.19	0.17
PY	0.04	0.02	-	0.07	0.13	-	0.04	0.07	0.04	0.15

ND not detected
- not determined

a FeO calculated such that Fe₂O₃/FeO = 0.2

Table 6-6b. Trace element data^a and inter-element ratios for texturally altered Mafic Komatiites.

SAMPLE	HSS-96	HSS-108	HSS-117	AB-21	HSS-38	HSS-118	HSS-122	HSS-148	KJ-40	SG-3
Nb	< 2.0	3.5	1.4	6.7	3.6	1.7	7.3	1.9	< 2.0	1.6
Zr	58	64	38.4	67	49.2	33.5	83	33.8	45.7	25.5
Y	20.1	19.2	14.1	18.7	19.5	13.7	33.6	12.3	15.6	8.1
Sr	118	215	181	63	167	78	85	28.7	33.2	27.6
Rb	6.6	11.4	11.1	3.9	5.4	29.4	3.5	0.7	1.1	1.7
Zn	141	70	112	120	70	108	135	62	97	100
Cu	262	18.3	14.1	124	82	< 2.0	874	76	< 2.0	60
Ni	195	183	170	561	238	447	370	310	458	1395
Co	81	65	69	89	70	90	103	72	84	124
Cr	416	765	814	-	747	1771	292	1747	2146	146
V	219	202	242	249	220	192	190	126	182	69
Ba	24.5	40.6	45.4	58	401	43.6	201	11.0	10.1	8.4
Ga	9.9	10.9	10.5	12.7	10.6	9.4	7.9	4.9	9.1	-
Sc	35.6	-	-	-	-	-	-	33.7	-	-
CaO/Al ₂ O ₃	1.03	1.10	1.17	1.19	1.36	1.53	3.19	3.83	1.04	1.26
Si/Ti	46	52	64	25.4	44	78	56.5	100	81.1	96
Al/Ti	10.8	11.3	13.1	5.6	9.0	13.8	5.1	7.9	16.1	15.8
Fe/Ti	19.0	16.6	22.3	14.0	17.8	28.3	25.9	31.3	27.7	39.6
Mg/Ti	11.1	12.4	17.0	7.6	12.6	26.3	19.1	37.3	33.3	52
Ca/Ti	15.1	16.9	20.7	9.0	16.5	28.4	21.9	40.8	22.6	27.0
Ti/Zr	90	76	101	132	110	93	52	74	66	95
Ti/Y	259	253	276	474	277	228	128	205	192	300
Ti/Ni	27	27	23	16	23	7.0	12	8.1	6.5	1.7
Ti/Co	64	75	56	100	77	35	42	20	36	19.5
Ti/V	23.8	24	16.1	35.6	24.5	16.2	22.7	20	16.5	16.5
Ti/Ga	527	446	371	699	509	332	546	514	329	288
Ti/Sc	147	-	-	-	-	-	-	75	-	-
Al/V	257	273	211	199	221	223	115	158	265	262
Ga/Alx10 ⁵	17.5	19.8	20.6	25.7	21.8	21.9	36.1	24.7	18.9	22.0
Zr/Nb	-	18.3	27.4	10.0	13.7	19.7	11.4	17.8	-	16
Zr/Y	2.9	3.3	2.7	3.6	2.5	2.4	2.5	2.7	2.9	3.2

- not determined

^a data as ppm and recalculated volatile free.

Table 6-7. Average compositions of the high-Mg and low-Mg mafic komatiites and the texturally altered mafic komatiites.

	High-Mg Mafic Komatiites		Low-Mg Mafic Komatiites			Texturally Altered Mafic Komatiites
	Aphyric	Porphyritic	Aphyric	Porphyritic	Rock	
SiO ₂	52.19	48.72	53.74	52.87	53.30	51.70
TiO ₂	0.40	0.56	0.74	0.69	0.72	0.73
Al ₂ O ₃	6.96	5.98	9.07	7.95	8.51	8.16
FeO*	8.73	12.55	11.15	11.12	11.14	12.14
MnO	0.16	0.18	0.19	0.21	0.20	0.23
MgO	21.74	21.85	11.72	13.72	12.72	13.32
CaO	8.36	9.20	10.63	10.94	10.78	11.60
P ₂ O ₅	0.04	0.05	0.08	0.06	0.07	0.05
Cr ₂ O ₃	0.39	0.35	-	-	-	-
Zr	25.1	37.6	56	52	54	50
Y	8.1	11.6	16.4	15.0	15.7	17.5
Ni	1203	1127	260	408	334	433
Co	96	112	69	78	74	85
Cr	-	-	964	1485	1224	1103
V	137	150	196	198	197	197
Ga	6.6	7.7	9.7	9.7	9.7	9.4
Sc	29.7	27.3	32.1	32.4	32.3	34.7
CaO/Al ₂ O ₃	1.20	1.54	1.17	1.38	1.27	1.42

Table 6-8 Distribution coefficients for clinopyroxene-liquid and olivine-liquid used in this work.

<u>Element</u>	<u>D^{cpx/liq}</u>	<u>Source</u>	<u>D^{ol/liq}</u>	<u>Source</u>
Zr	0.25	1	0.03	1
Y	0.70	1	0.13	1
Ni	2.40	2	<u>111.33-1.71</u> MgO	6
Co	1.22	3	1.9	Assumed
V	0.70	4	0.10	1
Ga	0.30	5	0.04	5
Sc	1.00	Assumed	0.22	1

Sources of data

- 1 Le Roex (1980)
- 2 This work- ppm Ni(cpx)/ppm Ni(bulk rock) for sample HSS-21
- 3 Dale and Henderson (1972)
- 4 Lindstrom (1976)
- 5 Goodman (1972)
- 6 This work-see Chapter 3

Table 6-9a Least squares approximation of the amount of $F_{0.7}$ that must be added to the basic low-Mg mafic komatiite composition to obtain the average Ultramafic komatiite liquid.

<u>Oxide</u>	<u>Observed</u>	<u>Estimated</u>	<u>Difference</u>	<u>Parameters of the 'Mix'</u>		
SiO ₂	47.11	47.33	0.22	<u>calculation</u>		
TiO ₂	0.36	0.35	-0.01	<u>Comp.</u>	<u>Wt. %</u>	<u>S.D.</u>
Al ₂ O ₃	3.93	3.89	-0.04	Init.Magma	100.0	-
FeO*	11.67	11.04	-0.63	F _{0.7}	44.6	0.90
MnO	0.19	0.18	-0.01	Basic low-Mg MK	55.1	0.98
MgO	28.95	28.91	-0.04			
CaO	6.74	6.37	-0.37			

$$\Sigma (\text{Calc-Obs})^2 = 0.59$$

Table 6-9b Estimated trace element content of the average basic low-Mg mafic komatiite assuming 44.6 wt. % olivine has been removed from the average ultramafic liquid composition.

<u>Trace element</u>	<u>Observed</u>	<u>Calculated</u>
Zr	48.6	48.8
Y	14.3	13.8
Ni	349	404
Co	74	74
Ga	8.0	8.5
Sc	32.6	33.2

Table 6-10. Average composition of the basic low-Mg mafic komatiites (13-15% MgO) and the evolved low-Mg mafic komatiites (9-13% MgO). The estimated composition of the evolved lavas obtained by the removal of 40 wt.% clinopyroxene from the basic lavas is also given.

	<u>Basic low-Mg mafic komatiite</u>	<u>Evolved low-Mg mafic komatiite</u>	<u>Endiopside</u>	<u>Calculated evolved mafic komatiite composition</u>
SiO ₂	53.57	53.85	52.78	53.52
TiO	0.63	0.79	0.35	0.82
Al ₂ O ₃	7.02	9.95	1.83	10.50
FeO*	11.13	11.12	5.86	14.69
MnO	0.21	0.19	0.15	0.25
MgO	13.88	10.70	18.85	10.56
CaO	11.31	10.42	18.52	6.48
Zr	48.6	59		71
Y	14.3	17.4		16.7
Ni	349	215		201
Co	74	66		66
V	171	207		200
Ga	8.0	10.4		11.5
Sc	32.6	32.6		32.6

Table 7-1a. Major element and normative mineral data for the low-Ti basalts.

SAMPLE	34-5	V-16	40-J	LV-7	V-36	M-390	HSS-518	HSS-56	HSS-58	HSS-43	LV-4
SiO ₂	51.76	50.33	50.87	51.18	52.99	52.07	55.65	50.71	52.05	50.07	50.15
TiO ₂	0.65	0.70	0.73	0.57	0.71	0.62	0.47	0.72	0.65	0.45	0.57
Al ₂ O ₃	14.90	15.81	15.07	15.68	14.61	15.05	13.66	15.57	15.25	16.14	14.54
Fe ₂ O ₃	1.68	1.72	1.79	1.47	1.63	1.71	1.52	1.74	1.67	1.49	1.66
FeO ^a	8.42	8.60	8.95	7.37	8.16	8.57	7.61	8.72	8.37	7.43	8.32
MnO	0.20	0.15	0.18	0.27	0.16	0.17	0.16	0.16	0.17	0.16	0.17
MgO	6.82	7.69	8.16	8.69	9.32	9.36	8.26	8.59	9.45	9.50	9.76
CaO	11.21	12.40	12.22	10.85	9.44	9.86	9.16	11.32	9.27	12.90	10.17
Na ₂ O	4.13	2.23	1.73	3.01	2.67	1.94	1.74	2.08	2.74	1.58	2.47
K ₂ O	0.14	0.23	0.13	0.83	0.22	0.52	1.56	0.09	0.20	0.18	2.11
P ₂ O ₅	-	0.04	0.06	-	-	-	0.06	0.05	0.06	0.04	-
S	0.03	0.05	0.06	0.04	0.03	0.06	0.07	0.20	0.06	ND	0.03
Cr ₂ O ₃	0.03	0.03	0.03	0.03	0.04	0.04	0.06	0.02	0.03	0.05	0.04
NiO	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00
LOI ₋	-	-	-	-	-	2.80	0.91	2.91	2.54	1.63	-
H ₂ O ⁺	0.10	0.03	0.16	0.12	0.08	-	0.09	0.10	0.19	0.17	0.06
H ₂ O	2.40	2.60	2.36	2.48	3.36	-	-	-	-	-	2.90
CO ₂	0.86	0.02	0.53	0.14	-	-	-	-	-	-	0.10
ORIG. TOTAL	98.64	99.14	99.71	100.53	99.99	100.21	100.48	101.28	99.87	100.83	99.26
NORMS											
QZ	(Ne 1.51)	-	1.66	-	0.95	1.48	6.65	0.25	-	-	(Ne 1.58)
OR	0.83	1.36	0.77	4.90	1.30	3.07	9.22	0.53	1.18	1.06	12.47
PL	53.87	51.32	47.61	52.29	49.82	47.24	39.58	50.48	51.91	49.79	40.34
DI	27.83	23.56	22.28	21.92	15.91	14.71	16.43	18.70	13.71	22.13	22.80
HY	-	16.10	23.39	3.64	28.19	29.65	24.66	25.57	27.21	21.10	-
CL	12.18	3.60	-	13.92	-	-	-	-	2.03	2.75	19.21
MT	2.44	2.49	2.60	2.13	2.36	2.48	2.20	2.52	2.42	2.16	2.41
CM	0.04	0.04	0.04	0.04	0.06	0.06	0.09	0.03	0.04	0.07	0.06
IL	1.23	1.33	1.39	1.08	1.35	1.18	0.89	1.37	1.23	0.85	1.08
AP	-	0.09	0.14	-	-	-	0.14	0.12	0.14	0.09	-
PY	0.06	0.09	0.11	0.07	0.06	0.11	0.13	0.37	0.11	-	0.06

ND not detected
- not determined

a FeO calculated such that Fe₂O₃/FeO = 0.2

Table 7-lb. Trace element data^a (ppm) and inter-element ratios for low-Ti basalts

SAMPLE	34-5	V-16	40-J	LV-7	V-36	M-390	HSS-518	HSS-56	HSS-58	HSS-43	LV-4
Nb	<1.0	<1.0	2.4	<2.0	<2.0	<1.0	3.2	2.0	<1.0	1.5	<2.0
Zr	44.1	42.5	44.5	35.8	40.4	38.5	58	39.0	37.4	27.5	34.3
Y	17.8	16.6	17.6	14.3	17.6	15.6	11.3	16.4	16.6	12.2	15.3
Sr	164	175	172	171	115	172	188	81	130	130	126
Rb	<2.0	10.9	1.1	27.6	1.8	79	64	2.2	3.8	2.3	50
Zn	72	85	77	150	70	77	69	84	84	137	77
Cu	113	140	128	168	135	260	69	134	143	33.6	150
Ni	187	207	172	140	156	178	176	174	193	185	174
Co	67	73	67	54	56	62	57	55	59	57	50
Cr	200	197	202	205	286	262	422	167	205	325	250
V	234	246	240	268	231	232	166	272	242	170	239
Ba	30.4	41.5	12.4	137	34.2	51	226	9.5	42.6	14.3	114
Ga	13.4	13.4	13.1	12.4	11.6	12.8	13.2	12.5	12.8	12.3	12.7
Sc	37.5	37.7	-	42.6	39.2	35.7	32.1	37.8	38.1	36.4	-
RATIOS											
CaO/Al ₂ O ₃	0.75	0.78	0.81	0.69	0.65	0.66	0.67	0.73	0.61	0.80	0.70
Si/Ti	62	56	54	70	58	65	92	55	62	87	69
Al/Ti	20	20	18	24	18	21	26	19	20	32	23
Fe/Ti	13	13	14	11	13	13	12	13	13	11	13
Mg/Ti	11	11	11	15	13	15	18	12.0	14.6	21.2	17.2
Ca/Ti	21	21	20	23	16	19	23	18.7	17.0	34.2	21.3
Ti/Zr	88	99	98	95	105	97	49	111	104	98	100
Ti/Y	219	253	249	239	242	238	249	263	235	221	223
Ti/Ni	21	20	25	24	27	21	16	25	20	15	20
Ti/Co	58	82	65	63	76	60	49	78	66	47	68
Ti/V	17	17	18	13	18	16	17	16	16	16	14
Ti/Ga	291	313	334	276	367	290	213	345	304	219	269
Ti/Sc	104	111	-	80	109	104	88	114	102	74	-
Al/V	337	340	332	310	335	343	436	303	334	502	322
Ca/Alx10 ⁵	17	16	16	15	15	16	18	15	16	14	17
Zr/Nb	-	-	19	-	-	-	18	20	-	18	-
Zr/Y	2.5	2.6	2.5	2.5	2.3	2.5	5.1	2.4	2.3	2.3	2.2

- not determined

^a data recalculated volatile free

Table 7-2a. Major element and normative mineral data for high-Ti basalts

SAMPLE	LV-9	21-J	SC-9	HSS-224
SiO ₂	52.50	52.08	50.23	49.78
TiO ₂	1.25	1.30	1.15	1.70
Al ₂ O ₃	14.32	13.54	13.73	14.23
Fe ₂ O ₃	1.79	2.18	2.55	2.58
FeO ^a	8.93	10.89	12.74	12.88
MnO	0.21	0.19	0.18	0.23
MgO	6.22	6.52	7.07	8.08
CaO	10.31	9.47	11.65	7.90
Na ₂ O	3.83	3.14	0.37	1.60
K ₂ O	0.58	0.55	0.07	0.81
P ₂ O ₅	-	-	0.13	0.18
S	0.06	0.12	0.09	0.02
Cr ₂ O ₃	0.01	0.02	0.02	0.01
NiO	0.01	0.01	0.02	0.01
TOTAL	100.00	100.00	100.00	100.00
LOI ₋	-	-	2.39	4.42
H ₂ O ₊	0.07	0.05	0.00	0.38
H ₂ O ⁺	2.59	3.30	-	-
CO ₂	0.23	0.23	-	-
ORIG. TOTAL	99.25	98.58	100.39	99.75
NORMS				
QZ	-	-	8.38	2.10
OR	3.43	3.25	0.41	4.79
PL	52.58	47.80	38.73	42.79
DI	25.49	21.31	17.73	7.24
HY	6.12	21.48	28.35	35.65
OL	7.30	0.27	-	-
MT	2.60	3.16	3.70	3.74
CM	0.01	0.03	0.03	0.01
IL	2.37	2.47	2.18	3.23
AP	-	-	0.31	0.43
PY	0.11	0.22	0.17	0.04

- not determined

a FeO calculated such that Fe₂O₃/FeO = 0.2

Table 7-2b. Trace element data^a (ppm) and inter-element ratios for high-Ti basalts

SAMPLE	LV-9	21-J	SC-9	HSS-224
Nb	3.6	4.4	3.4	4.6
Zr	99	109	82	134
Y	29.0	35.8	28.0	42.1
Sr	95	141	154	80
Rb	9.3	4.6	0.7	24.8
Zn	79	108	106	130
Cu	232	177	113	98
Ni	56	118	141	81
Co	42.5	62	73	59
Cr	44.6	109	141	92
V	322	391	338	363
Ba	37	64	7.5	228
Ga	10.7	17.2	14.7	19.0
Sc	-	35.8	39.2	34.2
RATIOS				
CaO/Al ₂ O ₃	0.72	0.70	0.85	0.56
Si/Ti	33	31	34	23
Al/Ti	10	9.2	11	7.4
Fe/Ti	14	17	20	20
Mg/Ti	5.0	5.0	6.2	4.8
Ca/Ti	9.8	8.7	12	5.5
Ti/Zr	76	72	84	76
Ti/Y	258	218	246	242
Ti/Ni	134	66	49	126
Ti/Co	176	126	94	173
Ti/V	23	20	20	28
Ti/Ga	700	453	469	536
Ti/Sc	-	218	176	298
Al/V	235	183	215	207
Ga/Alx10 ⁵	14	24	20	25
Zr/Nb	28	25	24	29
Zr/Y	3.4	3.0	2.9	3.2

- not determined

^a data recalculated volatile free

Table 7-3a. Major element and normative mineral data for high-Mg basalts

SAMPLE	HSS-2	HSS-23	HSS-35
SiO ₂	52.11	52.28	52.43
TiO ₂	0.38	0.32	0.29
Al ₂ O ₃	13.47	13.56	12.65
Fe ₂ O ₃	1.54	1.53	1.44
FeO ^a	7.69	7.64	7.20
MnO	0.16	0.16	0.14
MgO	12.00	13.43	14.78
CaO	7.91	7.18	7.97
Na ₂ O	2.08	3.00	1.72
K ₂ O	2.22	0.43	0.88
P ₂ O ₅	0.06	0.07	0.06
S	0.12	0.04	0.03
Cr ₂ O ₃	0.22	0.29	0.30
NiO	0.07	0.07	0.10
TOTAL	100.00	100.00	100.00
LOI ₋	3.50	3.40	3.96
H ₂ O ₊	0.18	0.12	0.26
H ₂ O ⁺	-	-	-
CO ₂	-	-	-
ORIG. TOTAL	99.94	99.57	100.35
NORMS			
QZ	-	-	-
OR	13.12	2.54	5.20
PL	38.46	47.65	38.75
DI	14.49	10.36	11.97
HY	17.79	23.48	35.78
OL	12.50	12.47	5.01
MT	2.23	2.22	2.09
CM	0.32	0.43	0.44
IL	0.72	0.61	0.55
AP	0.14	0.17	0.14
PY	0.22	0.07	0.06

- not determined

a. FeO calculated such that Fe₂O₃/FeO = 0.2

Table 7-3b. Trace element data^a (ppm) and inter-element ratios for high-Mg basalts

SAMPLE	HSS-2	HSS-23	HSS-35
Nb	2.8	2.4	<2.0
Zr	56	54	61
Y	16.8	13.7	13.6
Sr	207	287	268
Rb	48.2	8.4	22.0
Zn	71	65	57
Cu	51	42.0	36.7
Ni	539	574	770
Co	69	97	79
Cr	1491	1997	2067
V	138	135	99
Ba	349	128	134
Ga	11.7	10.5	10.7
Sc	36.4	35.4	-
RATIOS			
CaO/Al ₂ O ₃	0.59	0.53	0.63
Si/Ti	107	127	141
Al/Ti	31	37	39
Fe/Ti	12	12	11
Mg/Ti	32	42	51
Ca/Ti	25	27	33
Ti/Zr	41	36	29
Ti/Y	136	140	128
Ti/Ni	4.2	3.3	2.3
Ti/Co	33	20	22
Ti/V	17	14	18
Ti/Ga	195	183	162
Ti/Sc	63	54	-
Al/V	517	532	676
Ga/Alx10 ⁵	16	15	16
Zr/Nb	20	23	-
Zr/Y	3.3	3.9	4.5

- not determined

a data recalculated volatile free

Table 7-4a. Major element and normative mineral data for altered basalt and other lava types

SAMPLE	V-13	DC-1	HSS-39	HSS-83	HSS-111	HSS-52B
SiO ₂	50.39	51.58	52.19	56.70	52.09	66.55
TiO ₂	1.68	1.00	0.84	0.94	0.45	1.64
Al ₂ O ₃	15.13	14.05	17.40	11.72	16.06	13.20
Fe ₂ O ₃	2.23	3.22	1.55	1.63	1.26	0.37
FeO ^a	11.13	16.09	7.76	8.13	6.29	1.84
MnO	0.23	0.18	0.14	0.16	0.10	0.15
MgO	5.24	6.20	6.30	7.40	8.18	1.43
CaO	9.33	6.24	8.72	7.61	10.07	10.07
Na ₂ O	4.11	ND	3.81	3.96	3.60	1.70
K ₂ O	0.19	1.27	0.54	1.35	1.84	2.75
P ₂ O ₅	0.16	0.07	0.56	0.08	0.03	0.24
S	0.16	0.04	0.17	0.29	ND	0.06
Cr ₂ O ₃	0.01	0.05	0.02	0.02	0.01	0.00
NiO	0.01	0.03	0.00	0.01	0.04	0.00
TOTAL	100.00	100.00	100.00	100.00	99.99	100.00
LOI ₋	-	8.64	1.08	1.38	19.08	8.60
H ₂ O ₊	0.12	0.23	0.20	0.11	0.10	0.13
H ₂ O ⁺	3.41	-	-	-	-	-
CO ₂	4.60	-	-	-	-	-
ORIG. TOTAL	100.48	99.09	99.04	100.40	101.02	99.43
NORMS						
QZ	-	12.69	-	1.88	(Ne 3.30)	28.91
OR	1.12	7.50	3.19	7.98	10.87	16.25
PL	57.05	30.50	61.02	43.72	46.60	34.65
DI	19.13	-	8.86	22.03	22.28	8.81
HY	4.47	40.94	17.53	19.41	-	(Wo 7.09)
OL	11.07	-	3.87	-	14.20	-
MT	3.23	4.64	2.25	2.36	1.83	0.49
CM	0.01	0.07	0.03	0.03	0.01	-
IL	3.19	1.90	1.60	1.79	0.85	3.11
AP	0.38	0.17	1.33	0.19	0.07	0.57
PY	0.30	0.07	0.32	0.54	-	0.11

ND not detected
- not determined

a FeO calculated such that Fe₂O₃/FeO = 3587.67/17938.38

Table 7-4b. Trace element data^a (ppm) and inter-element ratios for altered basalts and other lava types

SAMPLE	V-13	DC-1	HSS-39	HSS-83	HSS-111	HSS-52B
Nb	5.2	<2.0	<1.5	<2.0	<1.0	6.9
Zr	125	60	84	74	33.2	155
Y	35.7	17.8	20.2	19.4	14.5	42.0
Sr	86	29.3	497	79	604	66
Rb	42	40.6	14.4	7.6	80	60
Zn	125	214	64	71	54	74
Cu	114	317	224	91	<2.0	57
Ni	100	221	22.7	100	281	25.4
Co	62	85	29.9	53	63	21.7
Cr	97	132	107	130	68	20.7
V	379	333	251	200	183	187
Ba	71	40.6	882	107	167	109
Ga	17.7	16.8	16.7	9.3	19.3	16.7
Sc	-	-	-	34.0	-	-
RATIOS						
CaO/Al ₂ O ₃	0.62	0.44	0.50	0.65	0.63	0.76
Si/Ti	23	40	48	47	90	32
Al/Ti	8.0	12	18	11	32	7.1
Fe/Ti	17	25	12	12	96	1.7
Mg/Ti	3.1	6.2	7.5	7.9	18	0.9
Ca/Ti	6.6	7.4	12	9.7	27	7.3
Ti/Zr	81	100	60	76	81	63
Ti/Y	282	337	249	290	186	234
Ti/Ni	101	27	222	56	9.6	387
Ti/Co	162	71	168	106	43	453
Ti/V	27	18	20	28	15	53
Ti/Ga	569	357	302	606	140	589
Ti/Sc	-	-	-	166	-	-
Al/V	211	223	367	310	464	374
Ga/Alx10 ⁵	22	23	18	15	23	24
Zr/Nb	24	-	-	-	-	22
Zr/Y	3.5	3.4	4.2	3.8	2.3	3.7

- not determined

^a data recalculated volatile free

Table 7-5 Tholeiitic basalt average compositions.

	Average Low-Ti basalt	Average High-Ti basalt	Average high-Mg basalt
SiO ₂	51.62	51.15	52.27
TiO ₂	0.62	1.35	0.33
Al ₂ O ₃	15.12	13.96	13.23
FeO*	9.71	13.41	8.87
MnO	0.18	0.20	0.15
MgO	8.69	6.97	13.40
CaO	10.80	9.83	7.69
P ₂ O ₅	0.05	0.16	0.06
Nb	<2.3	4.0	<2.6
Zr	40.2	106	57
Y	15.6	33.7	14.7
Ni	177	99	628
Co	60	59	82
Cr	247	97	1852
V	231	354	124
Ga	12.8	15.4	11.0
Sc	37.5	36.4	35.9

Table 7-6. Average inter-element ratios of chondrites, komatiites and basalts from the Onverwacht and lavas from other areas.

Lava type	Chondrites	STP from Neabitt and Sun (1976)		Low-Ti ultramafic lavas	Aphyric High-Mg mafic komatiites	Low-Ti ^c basalt	Famous basalts ^d	'Normal' ultramafic lavas	Main trend High-Mg mafic komatiites	Basic Low-Mg mafic komatiites	Evolved Low-Mg mafic komatiites	High-Ti basalts	Abyssal basalt	High-Mg basalts	Boninite (Dietrich et al., 1978)
n	-	7 ^a	3 ^b	2	5	10	-	15	3	5	17	4	-	3	5
MgO content	-	30.9	22.4	29.3	21.7	8.7	12.3	29.0	20.8	13.9	10.7	7.0	8.5	13.4	13.5
Al/Ti	18	18	20	16	16	22	22	10	10	10	11	9.3	10	36	47
Ca/Ti	20	24	28	32	27	21	24	22	23	21	16	9.0	10	28	34
Ti/Zr	102	111	117	124	99	100	113	79	85	78	80	77	83	35	38
Ti/Y	256	265	221	286	293	239	218	263	255	264	272	240	194	133	-
Ti/V	8.4	14	14	13	17	16	19	20	21	22	23	23	29	16	7.1
Ti/Sc	83	-	-	84	92	100	90	104	107	116	143	231	238	59	39
Ca/Alx10 ⁵	57(22-258)	-	-	19	19	16	15	23	22	22	20	21	22	16	-
Zr/Y	2.5	2.4	1.9	2.3	3.0	2.4	1.9	3.3	3.0	3.4	3.4	3.1	2.3	3.9	-
V/Zr	11.5	8.0	8.4	9.3	5.5	6.2	6.0	3.9	4.1	3.5	3.5	3.3	2.9	2.2	5.3
		GROUP I						GROUP II						GROUP III	

- a - STP rocks from Vilgarn block
- b - STP rocks from Munro Township
- c - Sample HSS-518 rejected from compilation
- d - Calculated primary magma composition from melt inclusions (Le Roex, 1980)

Table 7-7 Comparison of TiO₂, Zr and Y contents and inter-element ratios of basaltic rocks from Onverwacht, Scotia Sea Rise and Chilean Rocas Verdes ophiolites.

SAMPLE	Onverwacht	Scotia Sea	Chile	Onverwacht	Scotia Sea	C H I L E		
	Low-Ti basalts	Rise basalts	Rocas Verdes	High-Ti basalt	Rise basalt	R O C A S V E R D E S		
	ALL	D24.14	Gabbro PA31L	ALL	20.43B	Gabbro PA31D2	Dyke PA23G	Lava PB-16
TiO ₂	0.62	0.61	0.69	1.35	1.29	1.31	1.45	1.54
Zr	40	40	35	106	107	92	106	118
Y	16	14	19	34	29	31	36	30
Al/Ti	22	21	20	9.3	11	9.8	9.4	8.4
Ca/Ti	21	21	23	9.0	10	10	9.2	6.1
Ti/Zr	100	91	118	77	72	85	82	78
Zr/Y	2.4	2.9	1.8	3.3	3.7	3.0	2.9	3.9
Ga/Al×10 ⁵	16	16	17	21	19	22	26	22
Sm _N /Nd _N	1.04	0.99	-	0.95	0.91	-	0.86	-

Table 8-1. Bulk composition of orthopyroxene-olivine mixture entering melt. The estimated composition of the pyroxene is also given.

	<u>Bulk Composition</u>	<u>Orthopyroxene</u>	<u>D^{opx/liq(24% MgO)}</u>	<u>D^{opx/liq(33% MgO)}</u>
TiO ₂ %	0.20	0.31	0.7	1.0
Al ₂ O ₃ "	2.15	3.31	-	-
MgO "	38.97	33.00	-	-
CaO "	0.97	1.50	-	-
Zr(ppm)	14.4	22.2	0.7	1.0
Y "	6.1	9.3	1.0	1.3
V "	57	88	0.7	1.0
Ga "	2.8	4.3	0.8	1.1
Sc "	8.2	12.6	0.5	0.8

Table 8-2. Estimates of the amount of material that must be assimilated to generate the ultramafic magmas.

	<u>MgO content of initial melt</u>	<u>% source assimilated to generate 24% MgO lava</u>	<u>% source assimilated to generate 33% MgO lava</u>
Source composition	18%	30%	75%
with 38% MgO	24%	0%	64%
Source composition	18%	25%	63%
with 42% MgO	24%	0%	50%

Table 8-3. Calculated source mantle compositions for Group I and II ultramafic komatiites compared to other proposed mantle compositions.

	Calculated mantle 38.0% MgO	Continental ^b spinel herzolite at 38.0% MgO	Calculated mantle 39.0% MgO	Calculated mantle 38.0% MgO	PHN-1611	Calculated mantle 39.0% MgO	Calculated mantle 42% MgO	African garnet herzolite ^b at 42% MgO	Average Premier coarse grained garnet herzolite
	Group I		Group I	Group II		Group II	Group I		
SiO ₂	45.6	45.5	45.4	44.4	44.5	44.1	45.00	46.88	45.83
TiO ₂	0.13	0.11	0.12	0.22	0.26	0.20	0.09	0.10	0.11
Al ₂ O ₃	2.6	3.5	2.4	2.3	2.8	2.1	1.85	1.64	2.12
FeO*	8.7	8.2	8.3	10.9	10.3	10.9	7.41	7.18	6.95
MnO	0.21	0.13	0.21	0.17	0.13	0.16	0.21	0.11	0.14
MgO	38.0	38.0	39.0	38.0	37.9	39.0	42.00	42.00	41.72
CaO	3.4	3.5	3.1	1.5	3.3	0.96	2.14	1.27	1.54
Cr ₂ O ₃	0.45	0.42	0.45	0.26	0.29	0.25	0.43	0.38	0.36
Zr	6.3 ^a	-	5.8 ^a	16	-	14	4.3 ^a	-	-
Y	2.7 ^a	-	2.5 ^a	6.3	-	6.0	1.8 ^a	-	-
Ni	2570	1800	2660	2420	-	2510	2920	2190	2040
Co	127	-	126	160	-	164	125	-	-
V	77	-	74	62	-	57	63	-	-
Ga	2.5 ^a	-	2.4 ^a	3.0	-	2.8	1.7 ^a	-	-
Sc	9.3 ^a	-	8.7 ^a	9.4	-	8.1	6.3 ^a	-	-

a calculated from Ti/element ratio in HSS-95

b calculated from regression equations given by Maaloe and Aoki (1977).

Table 8-4. Estimated degree of melting (F) for tholeiitic basalts from source material with 38% MgO given in Table 8-3.

<u>Source/Tholeiite</u>	F <u>Group I Tholeiites</u>	F <u>Group II Tholeiites</u>
Ti	0.21	0.16
Al	0.17	0.16
Zr	0.16	0.15
Y	0.17	0.19
Ga	<u>0.20</u>	<u>0.19</u>
Average F	0.18	0.17

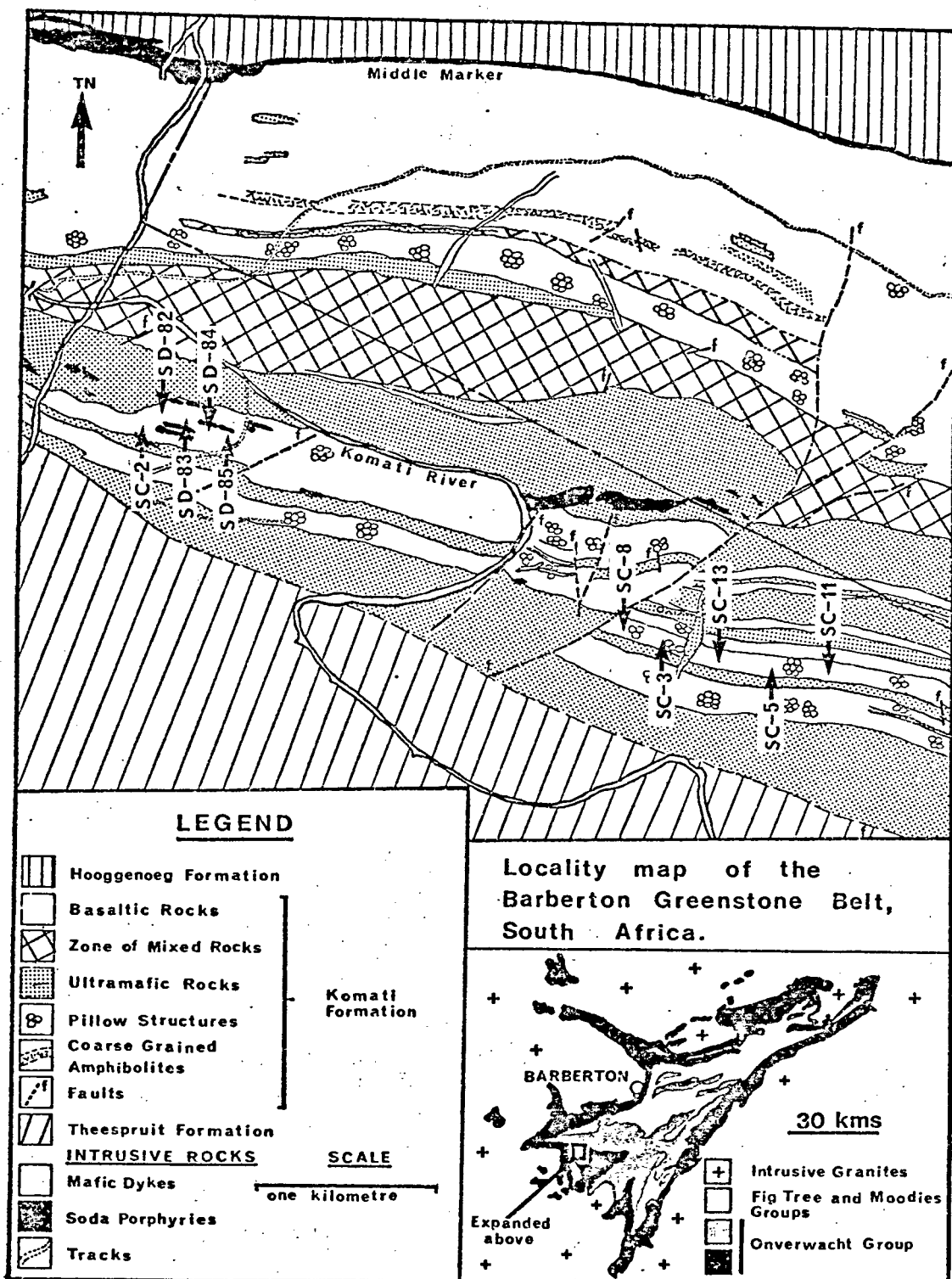


Fig. 2-1. A simplified geological map of the type area of the Komati Formation, Barberton greenstone belt, taken from Viljoen and Viljoen (1969c), showing the location of the pillow lavas sampled.

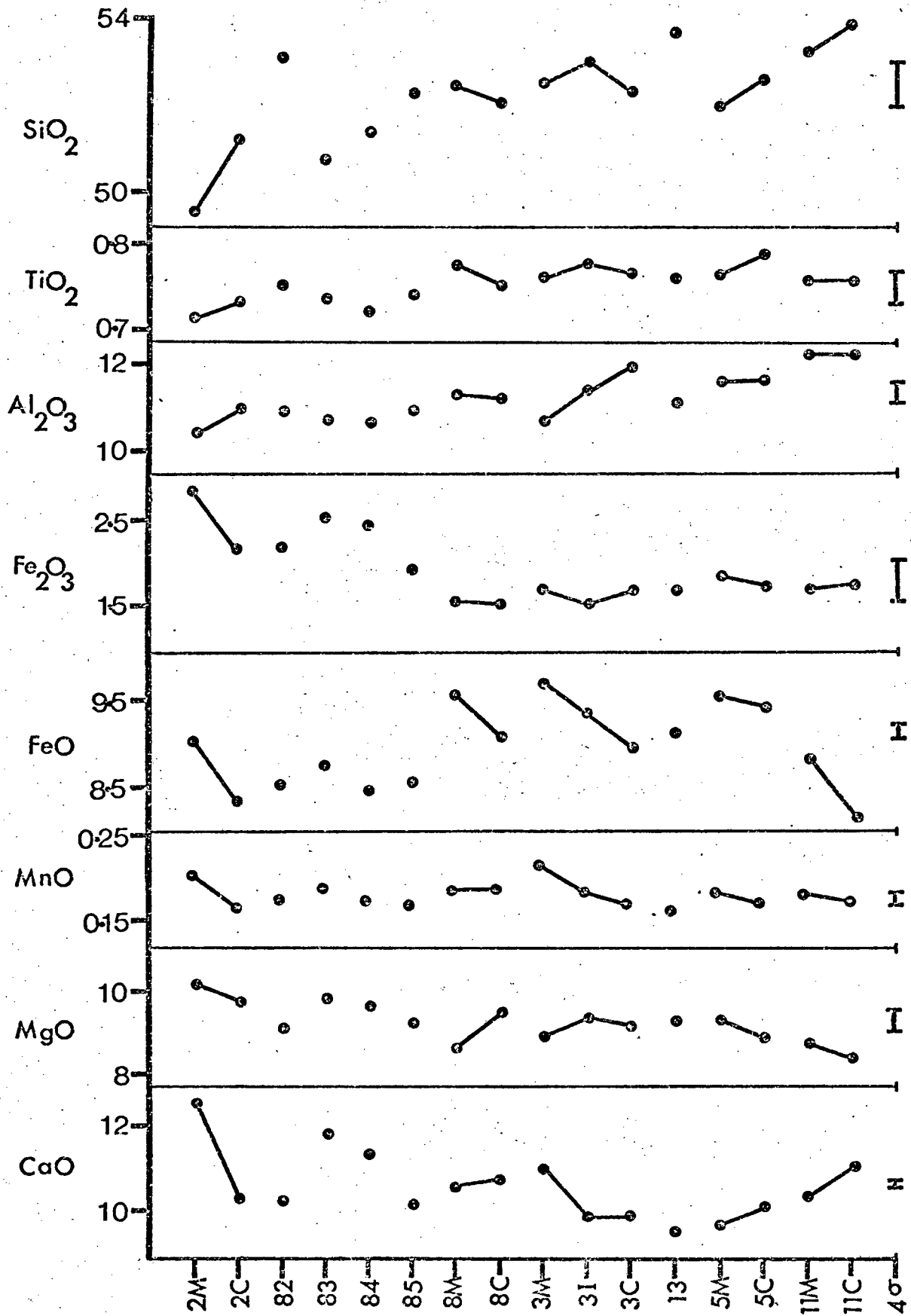


Fig. 2-2. Plot of the major and trace element data of the pillow samples from Tables 2-1 and 2-2. The plot is arranged such that the western-most pillow is on

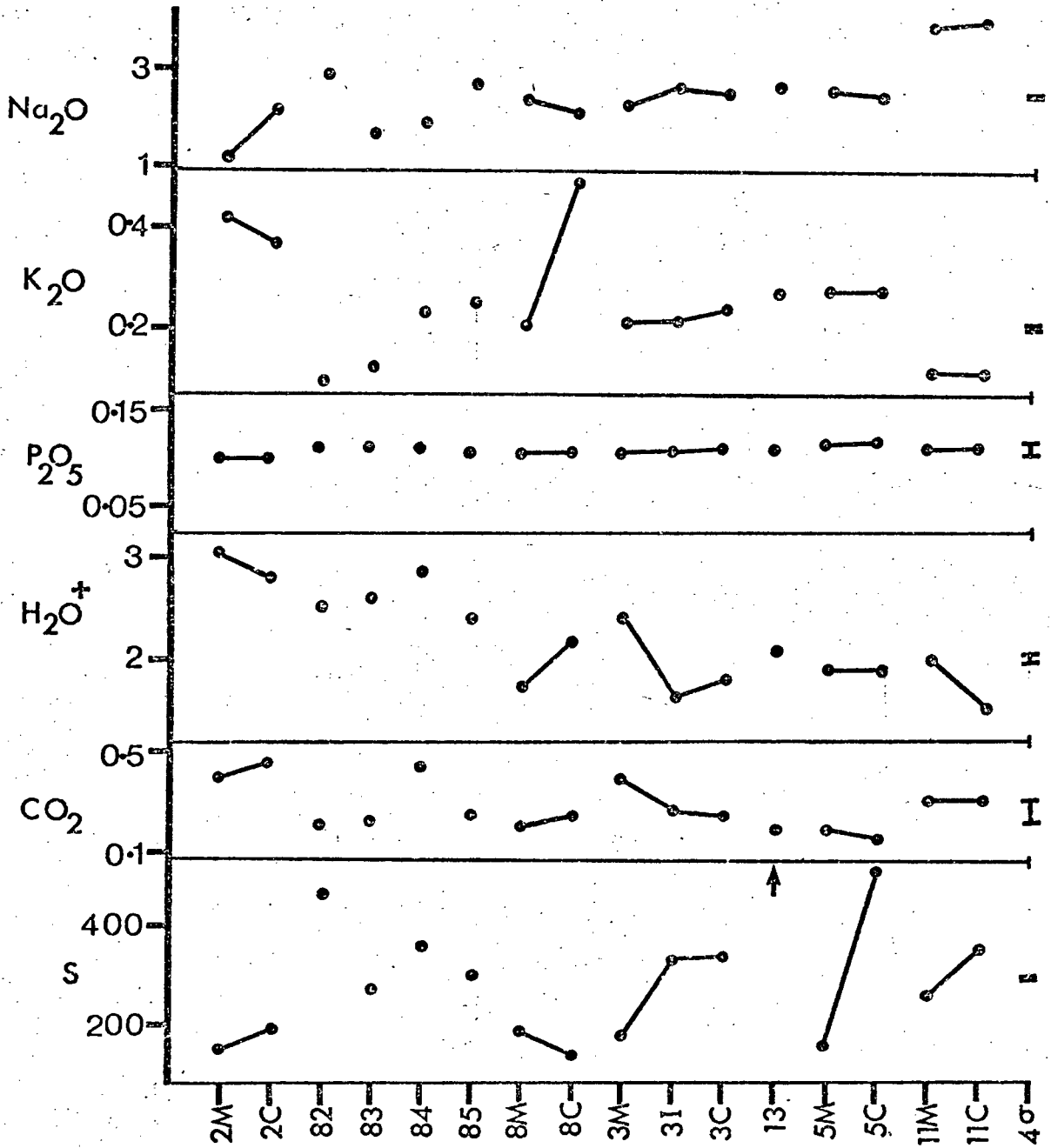


Fig. 2-2. (Continued) the left progressively through to the eastern-most pillow on the right. The pillow pairs are joined by tie-lines, margin on the left and

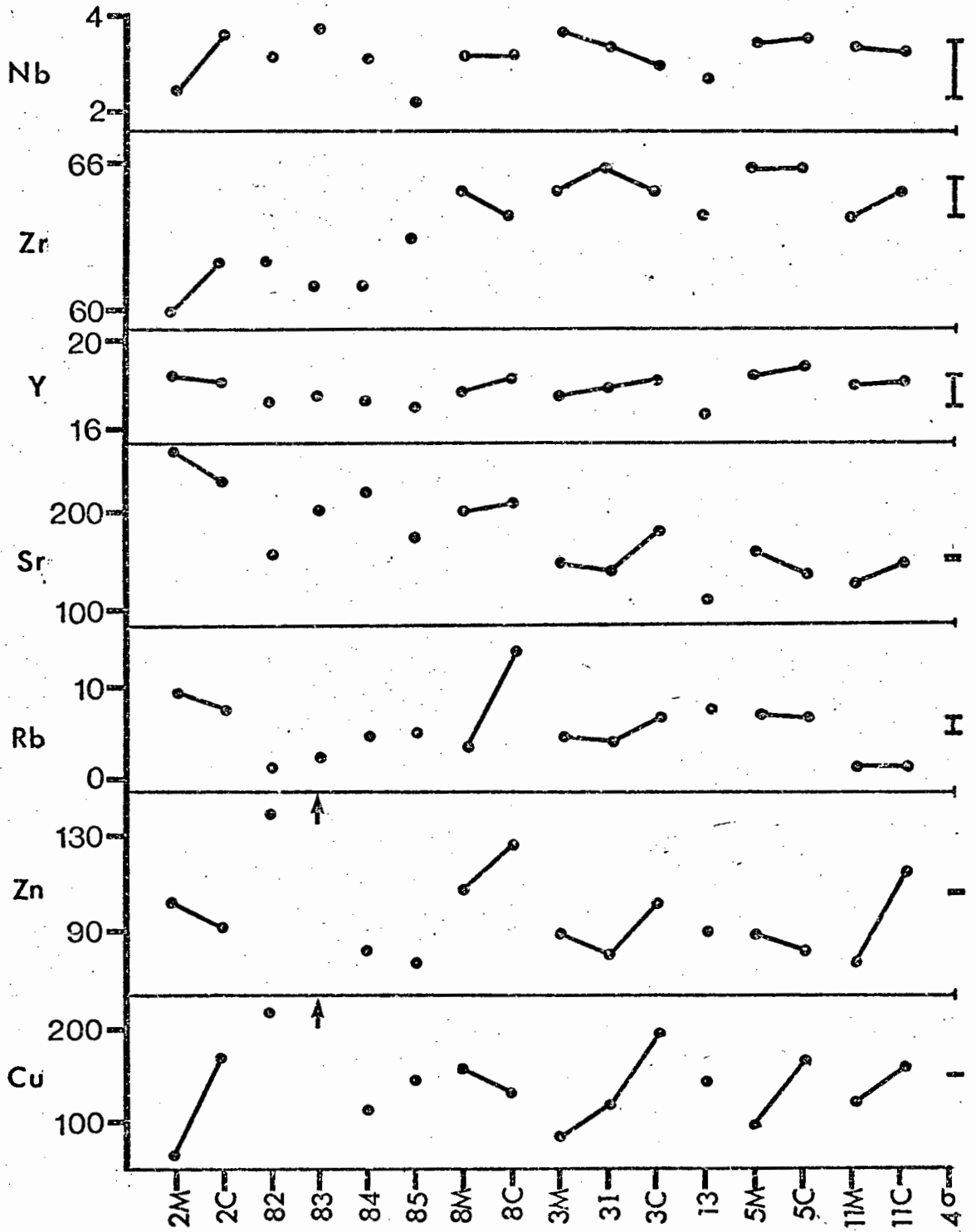


Fig. 2-2 (Continued) core on the right. The spacing between the samples in the diagram has no field separation connotations. Analytical error bars $\pm 2\sigma$ (i.e. 4σ) for each element are indicated on the right of each plot.

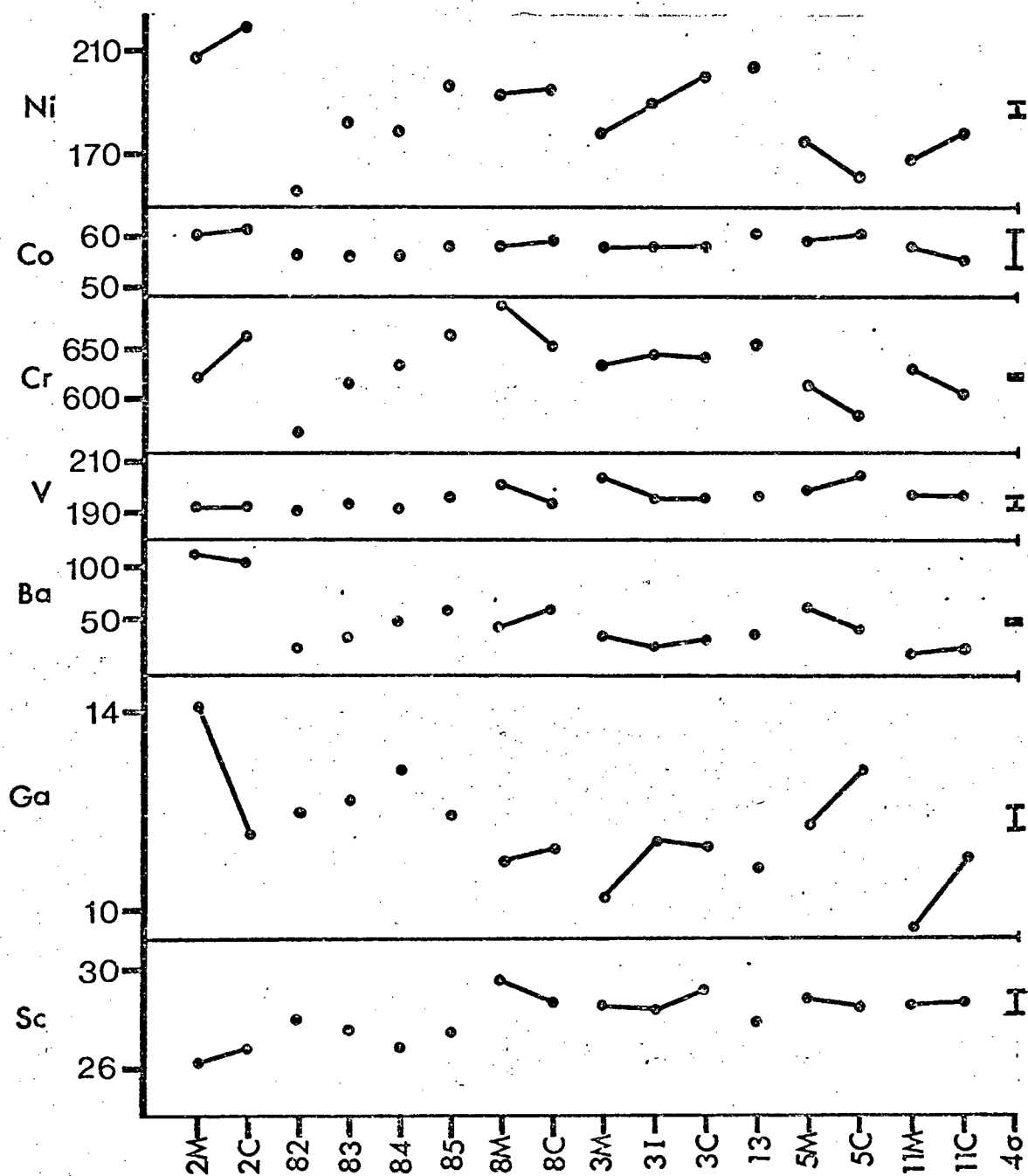


Fig. 2-2 (Continued)

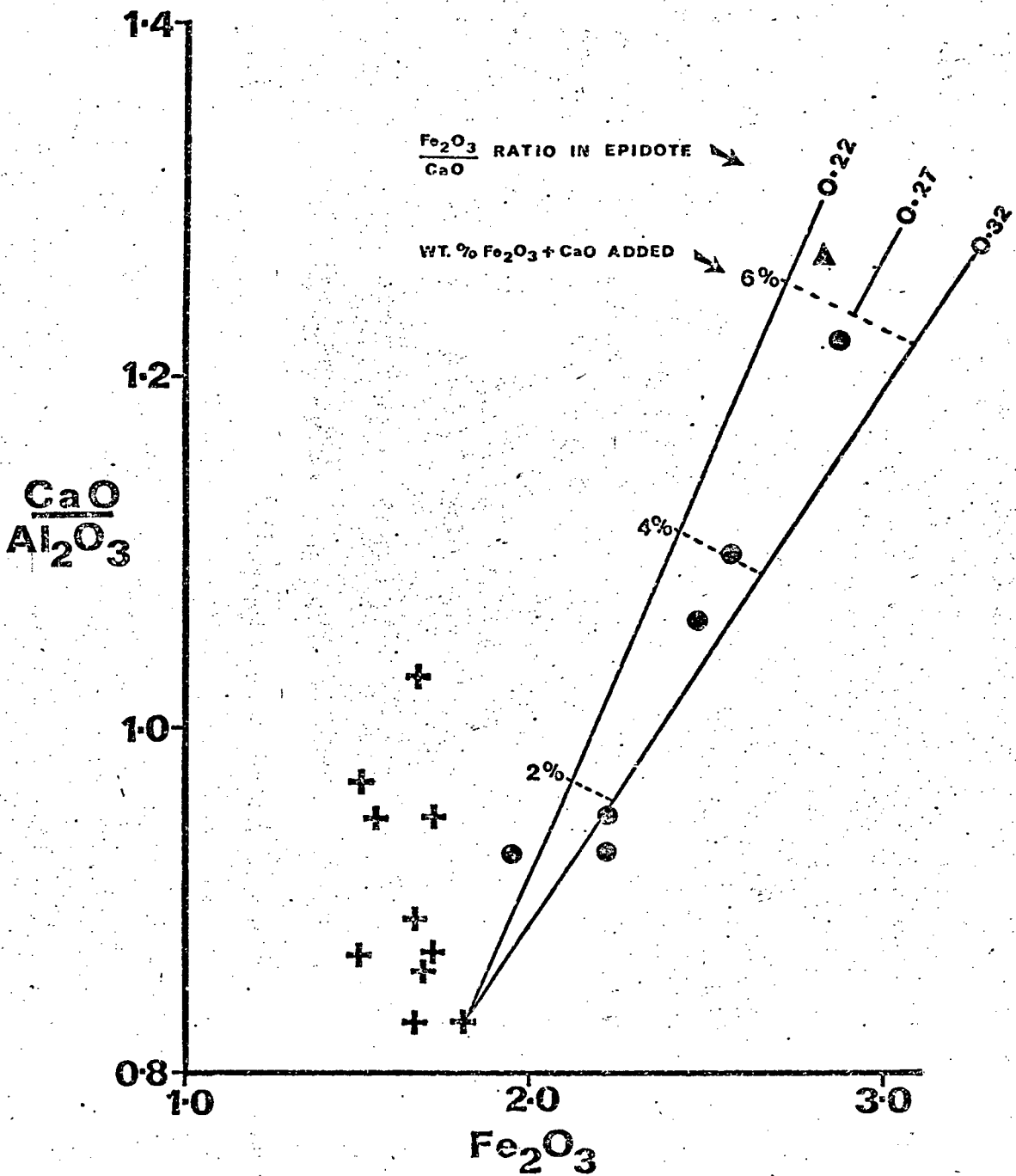


Fig. 2-3. Plot of $\text{CaO}/\text{Al}_2\text{O}_3$ against Fe_2O_3 for all the pillow analyses. The eastern ('fresher') pillows are plotted as crosses and the western pillows as dots. The filled triangle is sample 14-J from Viljoen and Viljoen (1969c). The effect of adding CaO and Fe_2O_3 to form epidote using SC-5M as the starting composition is indicated.

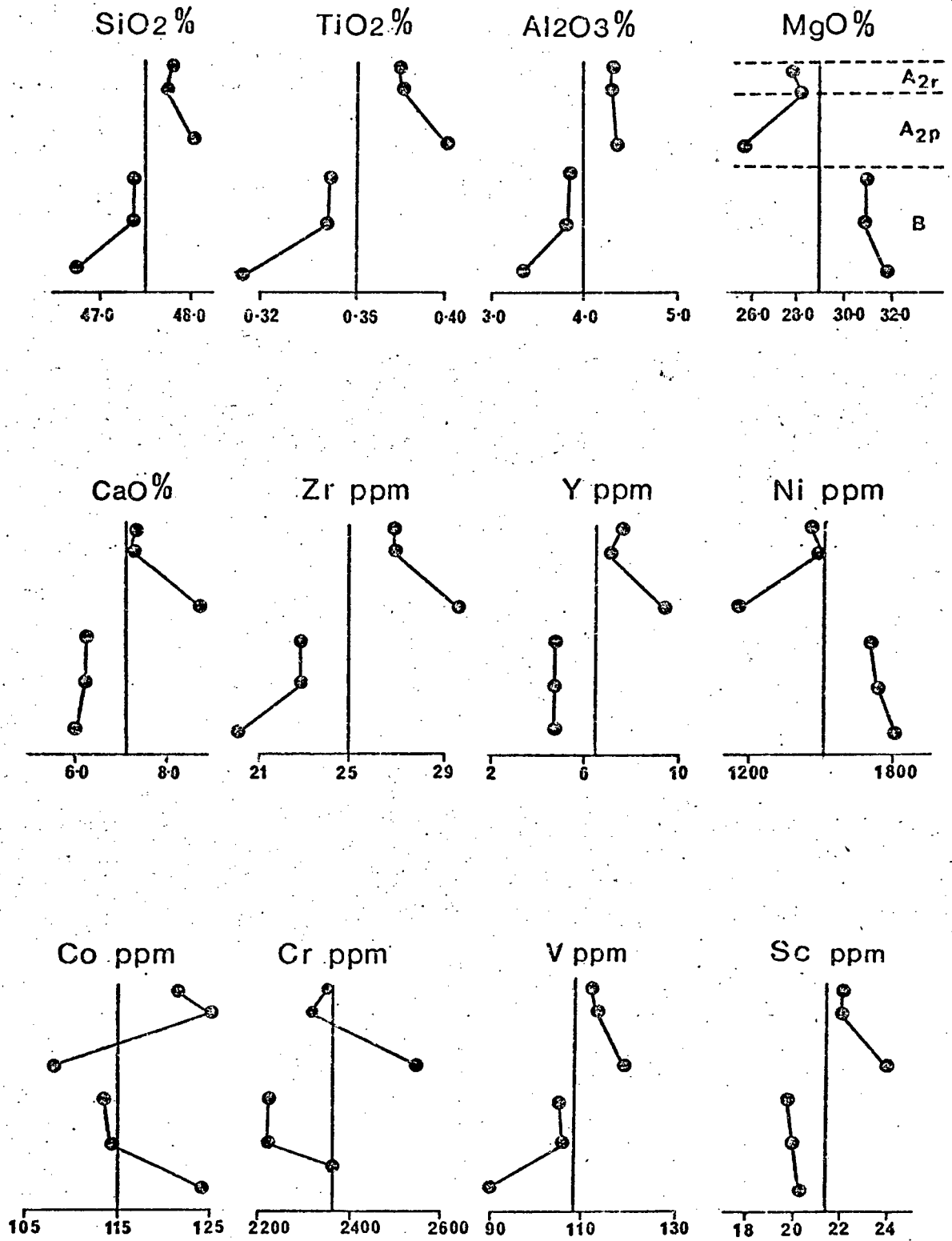


Fig. 3-2. Variations of the concentrations of selected elements as a function of position in Stuart's flow. The vertical line on each plot represents the weighted average concentration and the textural zones of the flow are demarcated on the MgO plot only.

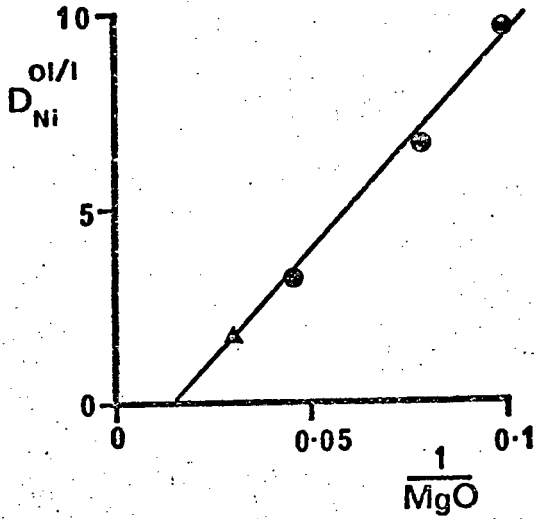


Fig. 3-3. Plot of D_{Ni} vs. $1/MgO$ for the experimental data given in Arndt (1977b) (dots) and data for sample 49-J from Green et al. (1975) (solid triangle). All data used for the plot are komatiite compositions and the equation for the regression line is $D_{Ni} = 111.33/MgO - 1.71$.

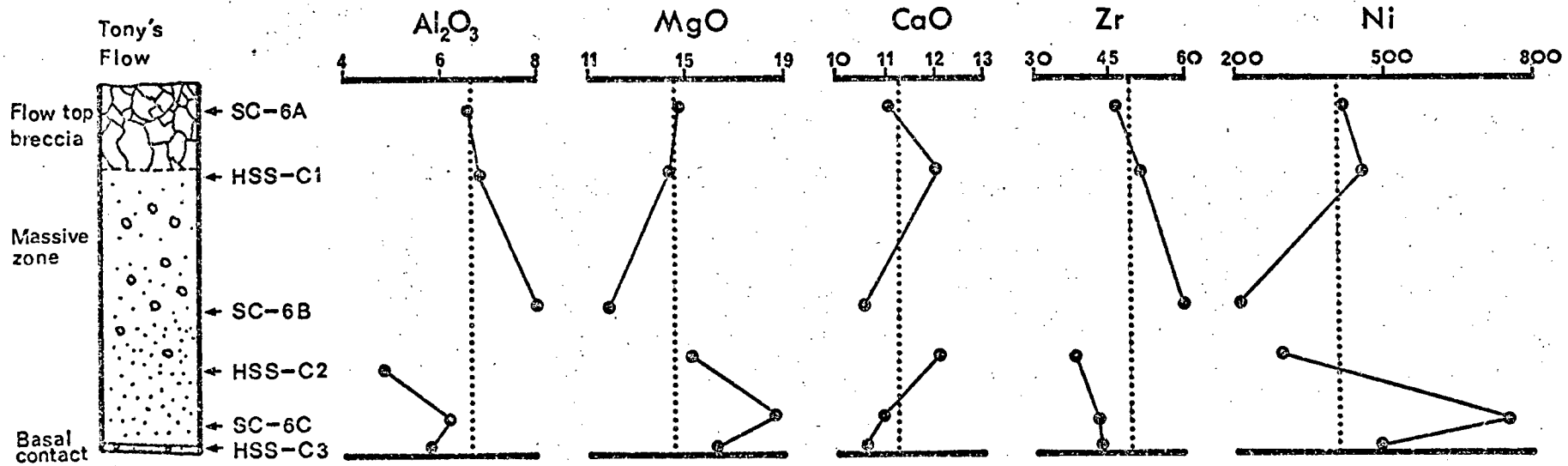


Fig. 3-4. A diagrammatic section through the 7.3m thick mafic komatiite flow (Tony's flow) from the Komati Formation. Sampling points are indicated by arrows. The variations of concentration of selected elements as a function of position in Tony's flow are also shown. The dotted line on each plot represents the weighted average concentration of the element.

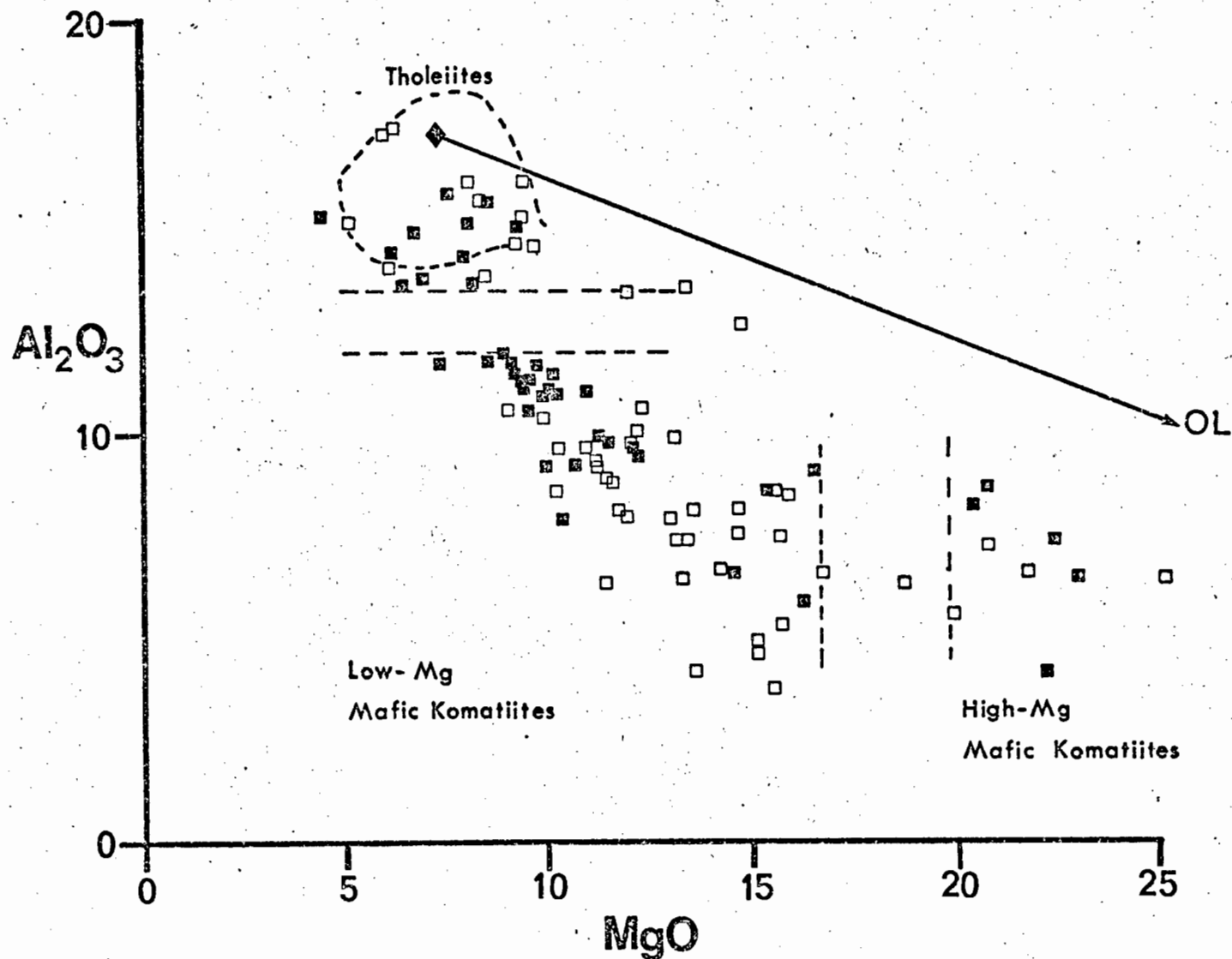


Fig. 4-1. Plot of all rocks analysed with MgO contents between 5 - 24% MgO . Aphyric lavas as solid squares and porphyritic samples as open squares. The outlined field encloses MORB compositions and the diamond symbol is average MORB from Engel et al(1965).

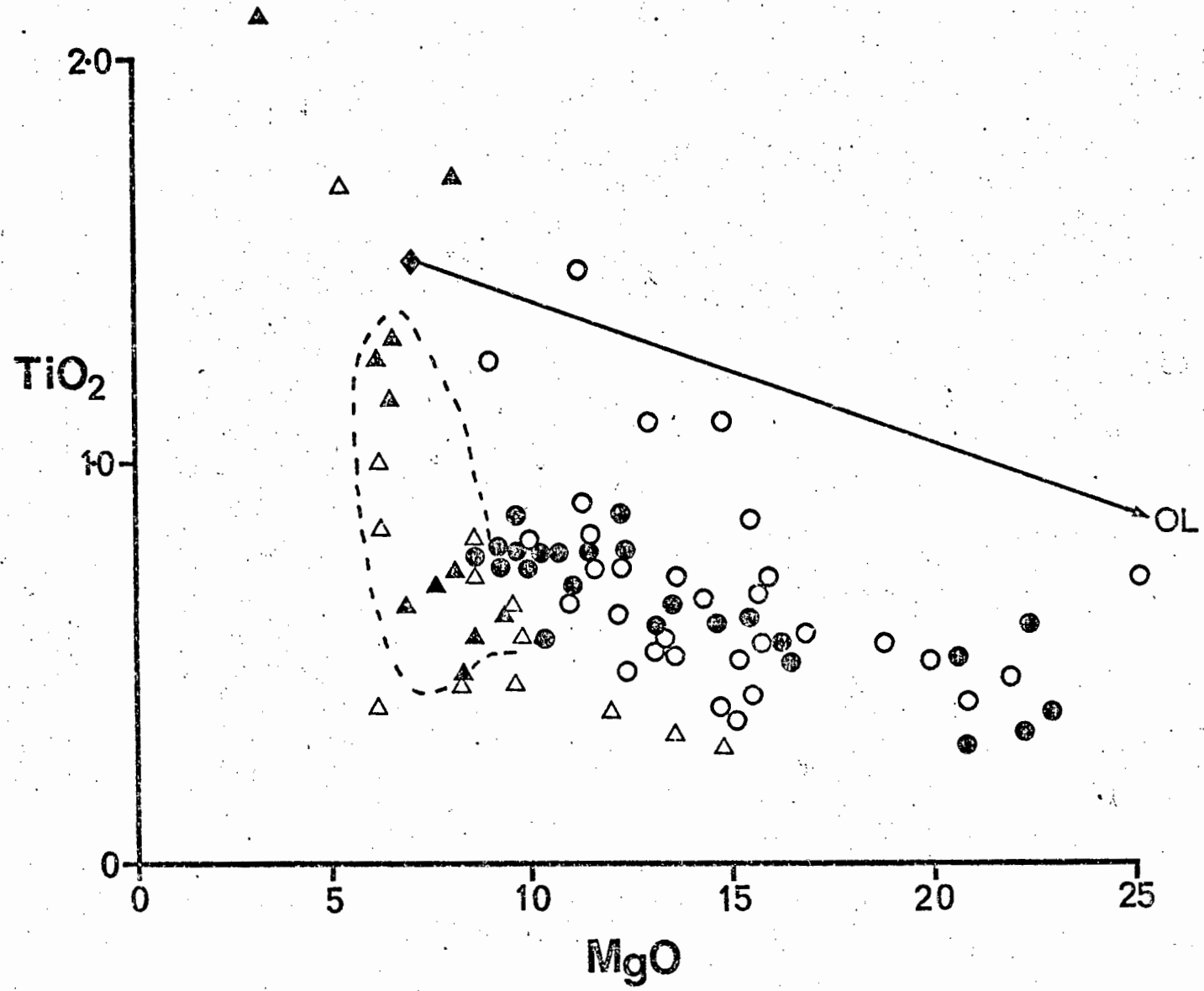


Fig. 4-2. Mafic komatiites as dots and tholeiites as triangles; aphyric lavas as filled symbols; porphyritic samples as open symbols; outlined field and diamond symbol as in Fig. 4-1.

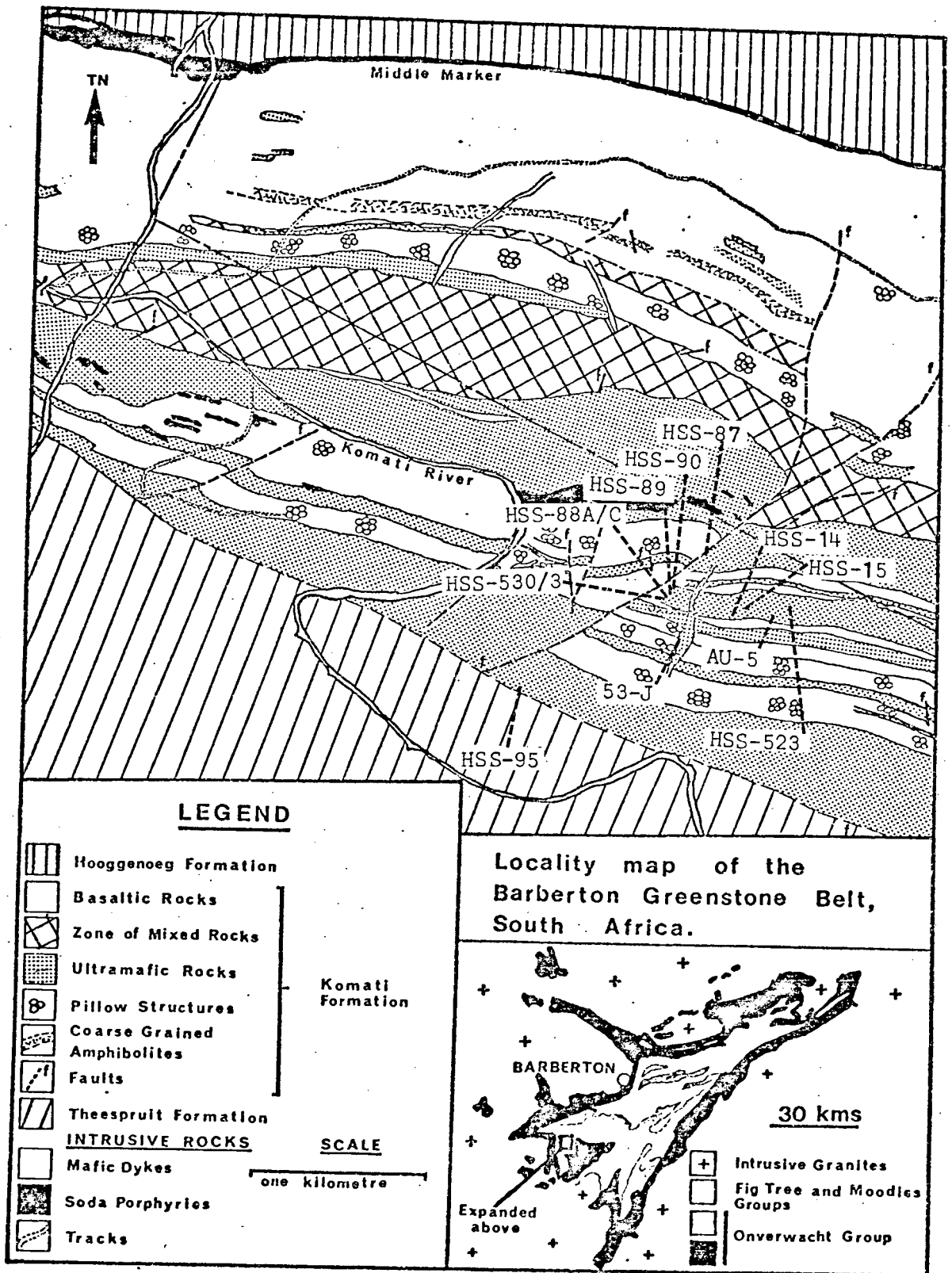


Fig. 5-1. A simplified geological map of the Komati Formation Type Area taken from Viljoen and Viljoen (1969c). The sample locations of the group of aphyric ultramafic komatiite lavas are shown.

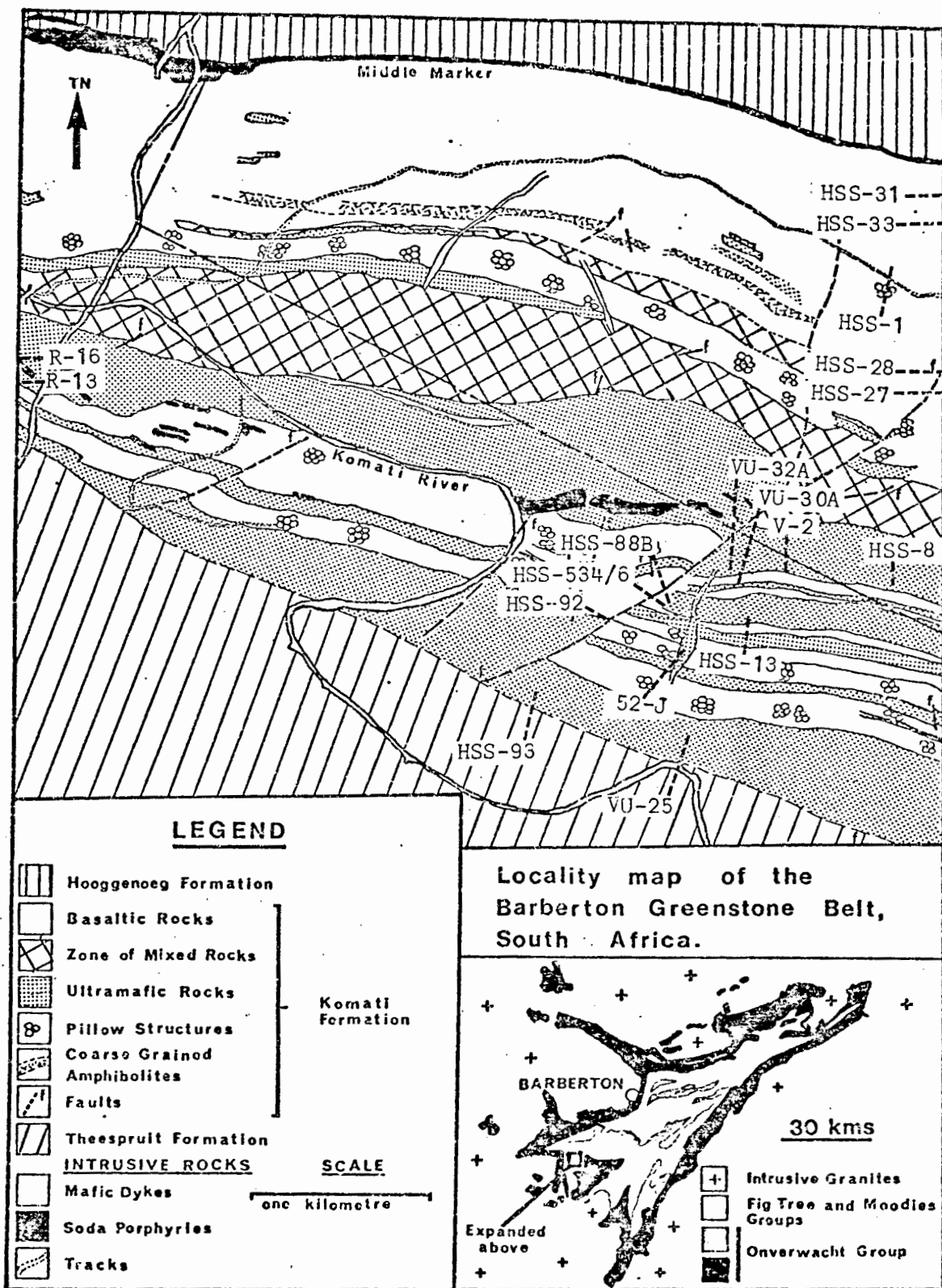


Fig. 5-2. A simplified geological map of the Komati Formation Type Area taken from Viljcen and Viljoen (1969c). The sample locations of the group of porphyritic ultramafic komatiite rocks are shown.

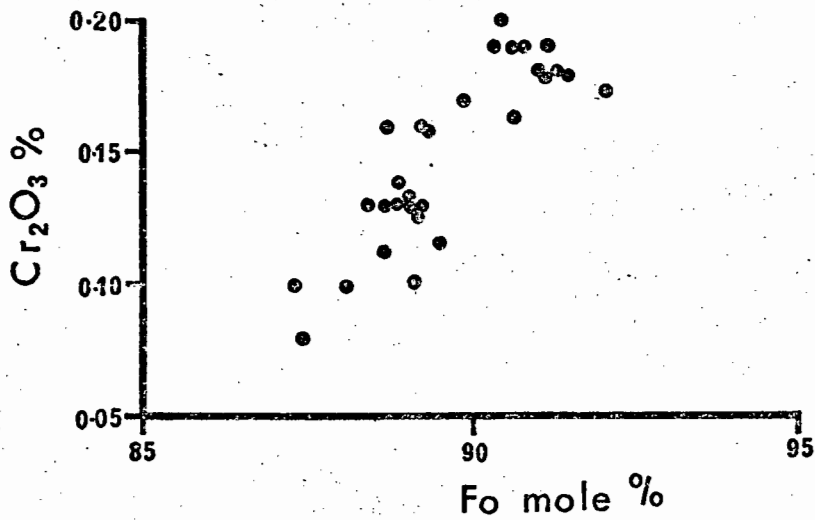


Fig. 5-3. Variations of the Cr₂O₃ (wt.%) content with forsterite content in olivines from the LUU ultramafic komatiites.

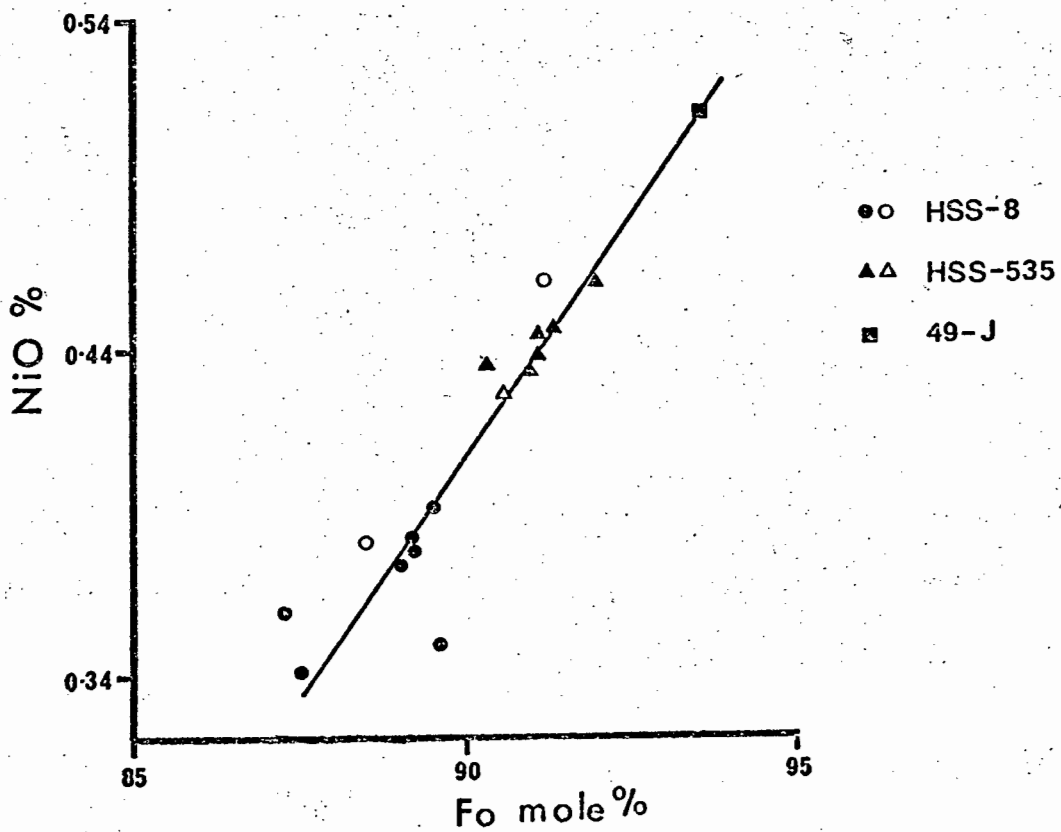


Fig. 5-4. Variations of the NiO (wt.%) content with forsterite content in olivines from the LUU ultramafic komatiites. Open symbols are partial analyses.

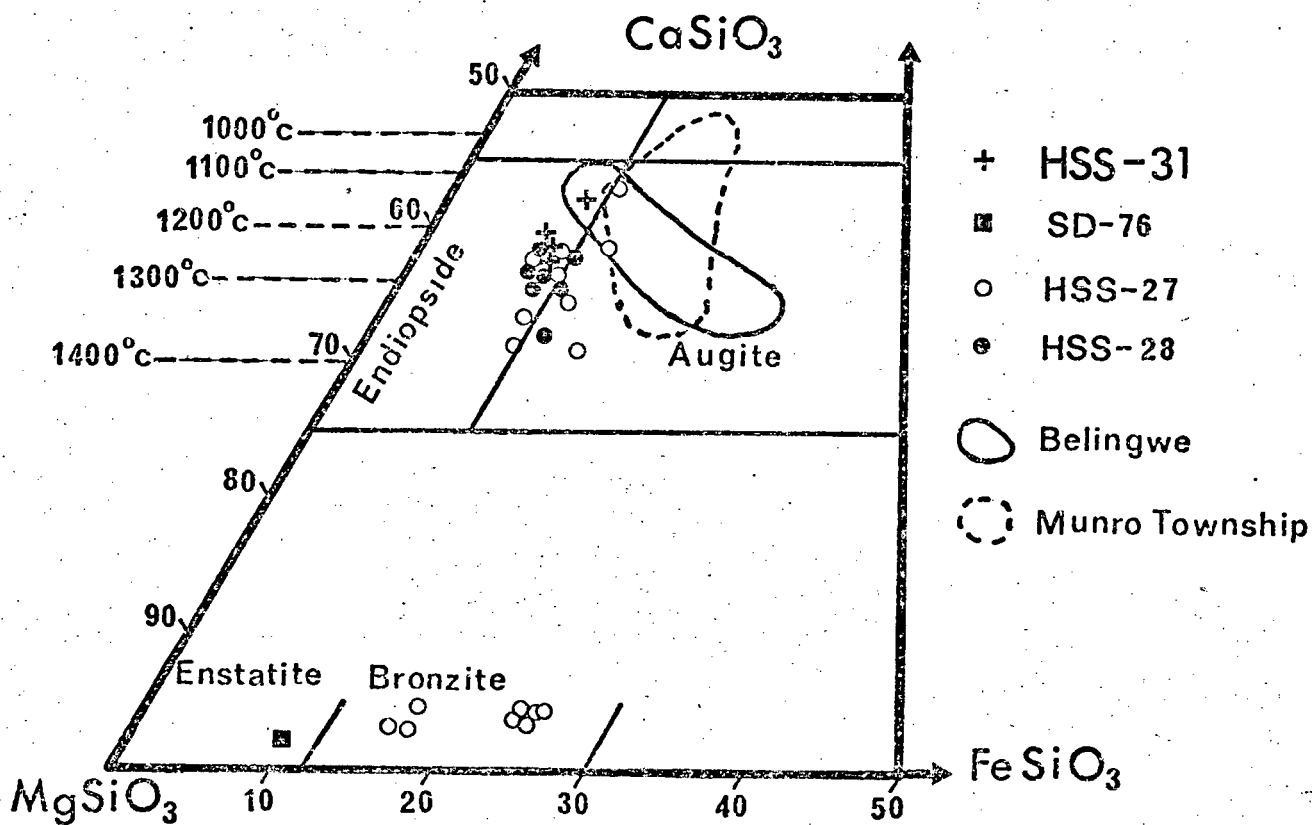


Fig. 5-5. Pyroxene compositions in the LUU ultra-mafic komatiites compared to pyroxene compositions from Belingwe and Munro Township komatiites.

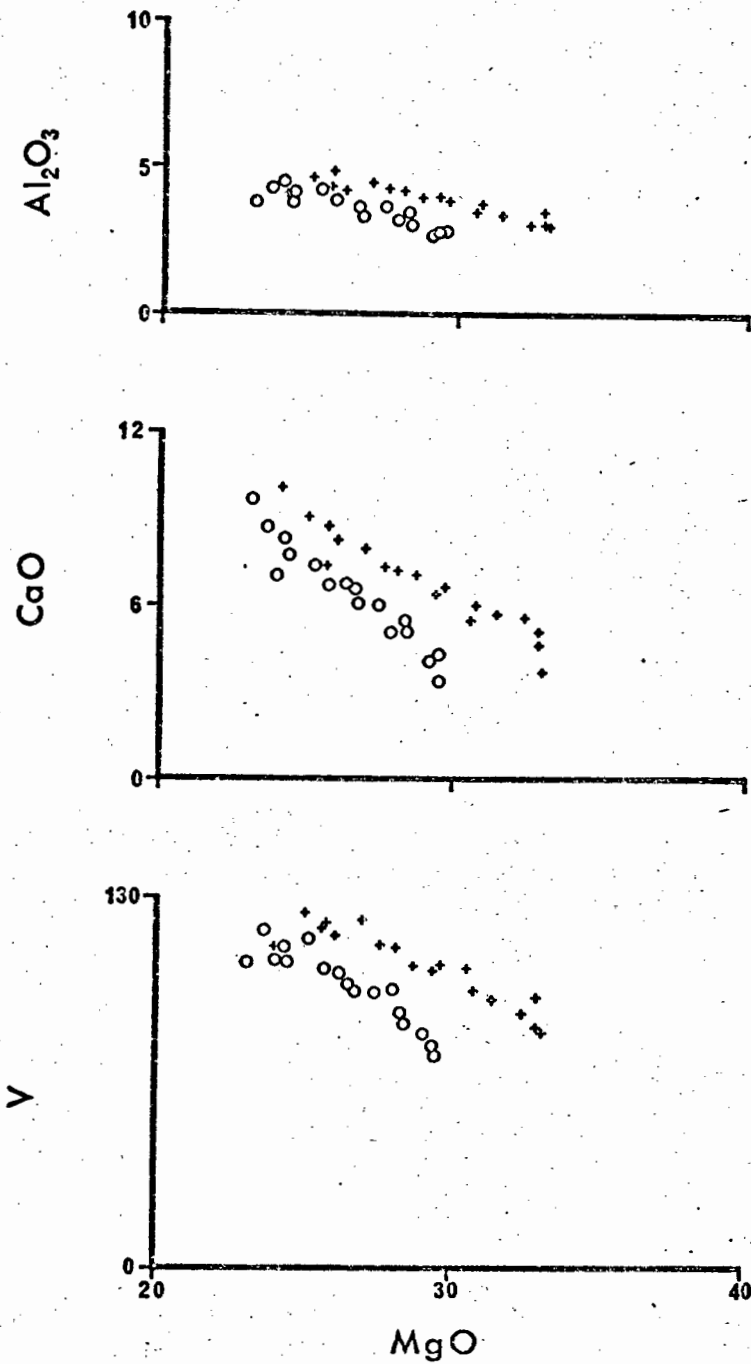


Fig. 5-6. Al₂O₃, CaO (both wt.%) and V (ppm) plotted against MgO content (wt.%) for the aphyric group of ultramafic komatiites. The circles represent the concentrations before the data were recalculated volatile free and the crosses are the concentrations after the data were recalculated volatile free.

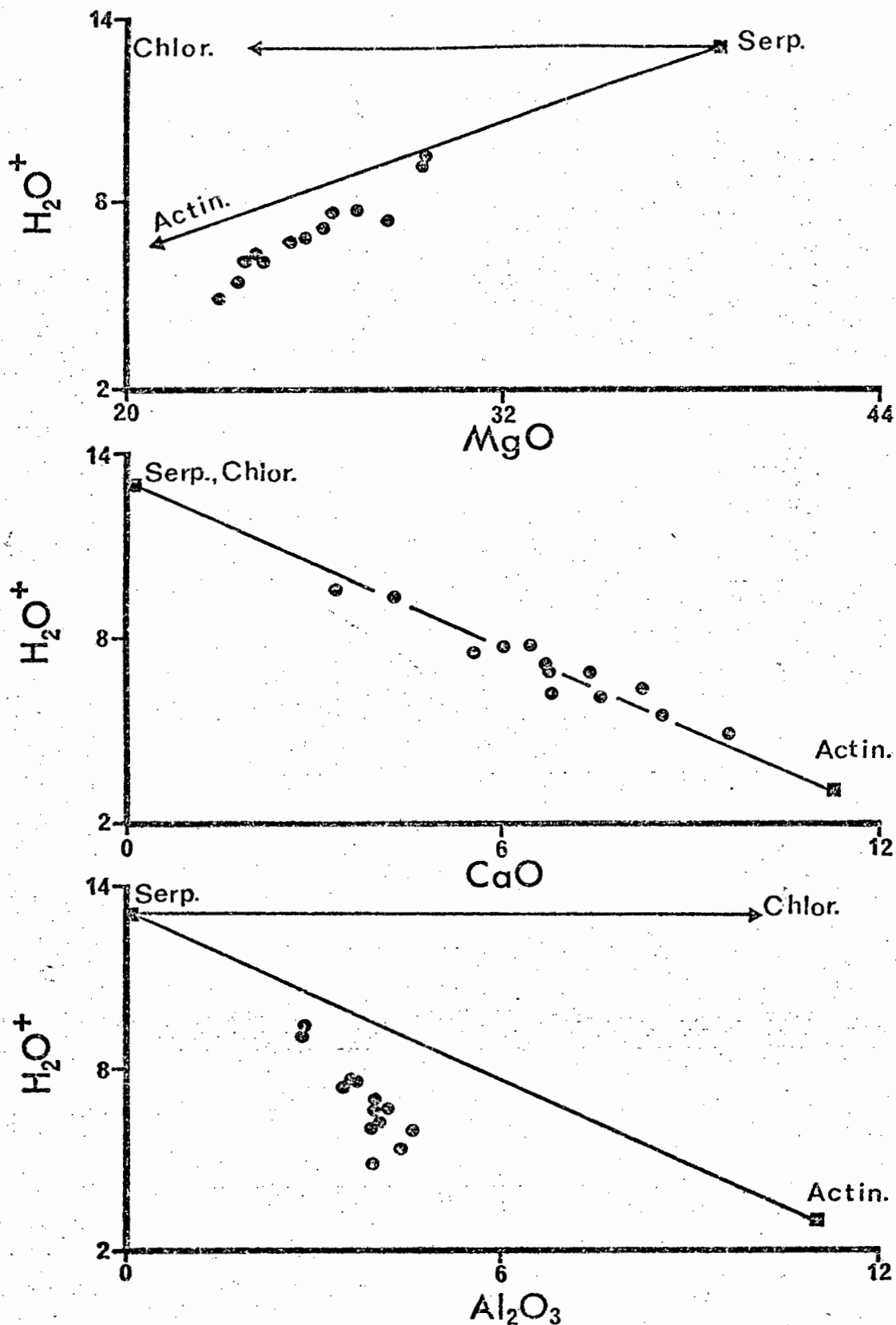


Fig. 5-7a. Variations of selected oxide concentrations (wt. %) with H_2O^+ content (wt. %) from the aphyric ultramafic komatiites from the LJU. Note that the data has not been recalculated volatile free. Compositions of common alteration minerals observed in the ultramafic rocks are also plotted. Serp.-serpentine, chlor.-chlorite and actin.-actinolite.

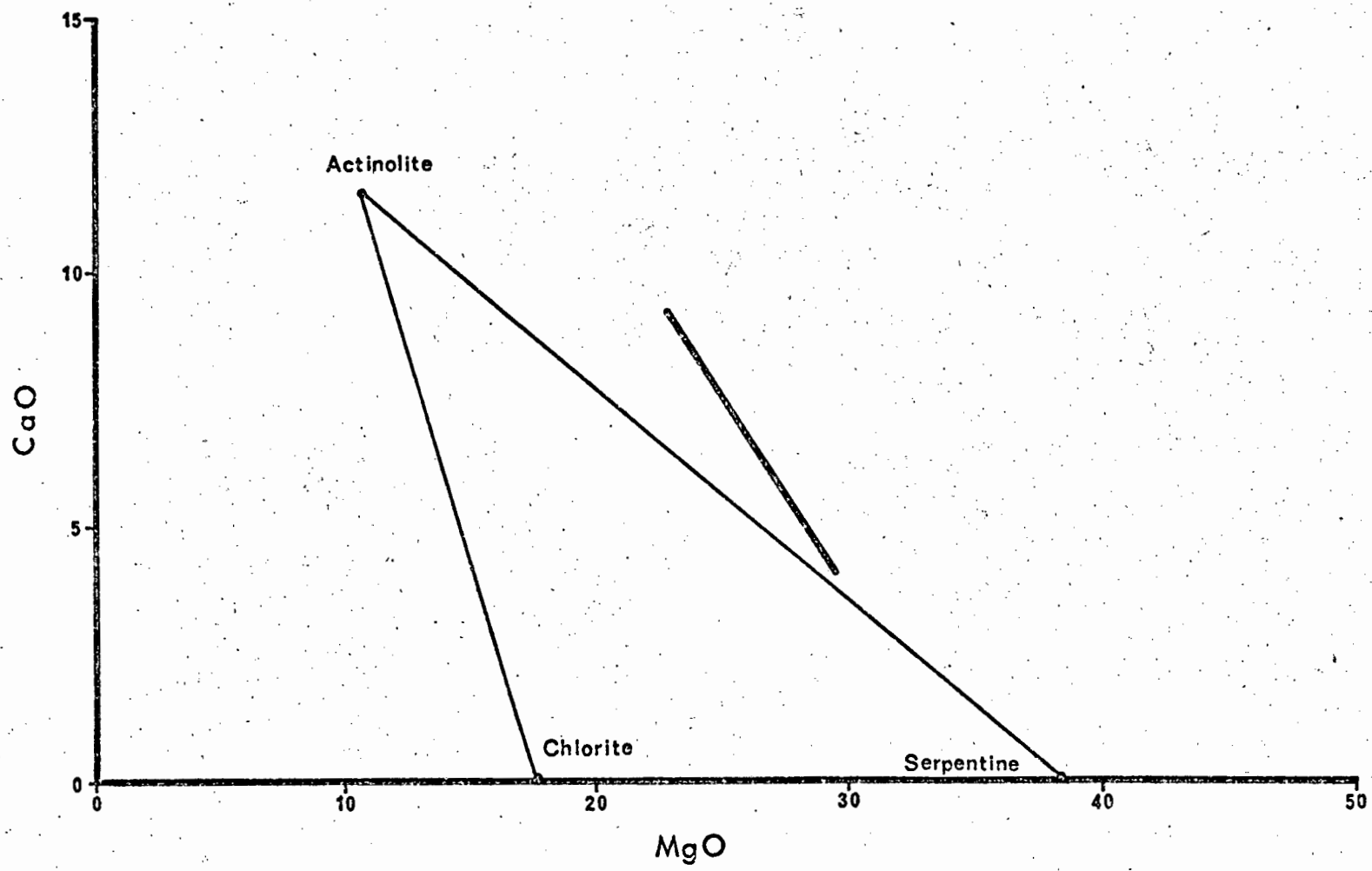


Fig. 5-7b. The CaO-MgO trend (heavy line) for the aphyric ultramafic komatiites (data not recalculated volatile free) shown in relation to the compositions of some major secondary mineral phases.

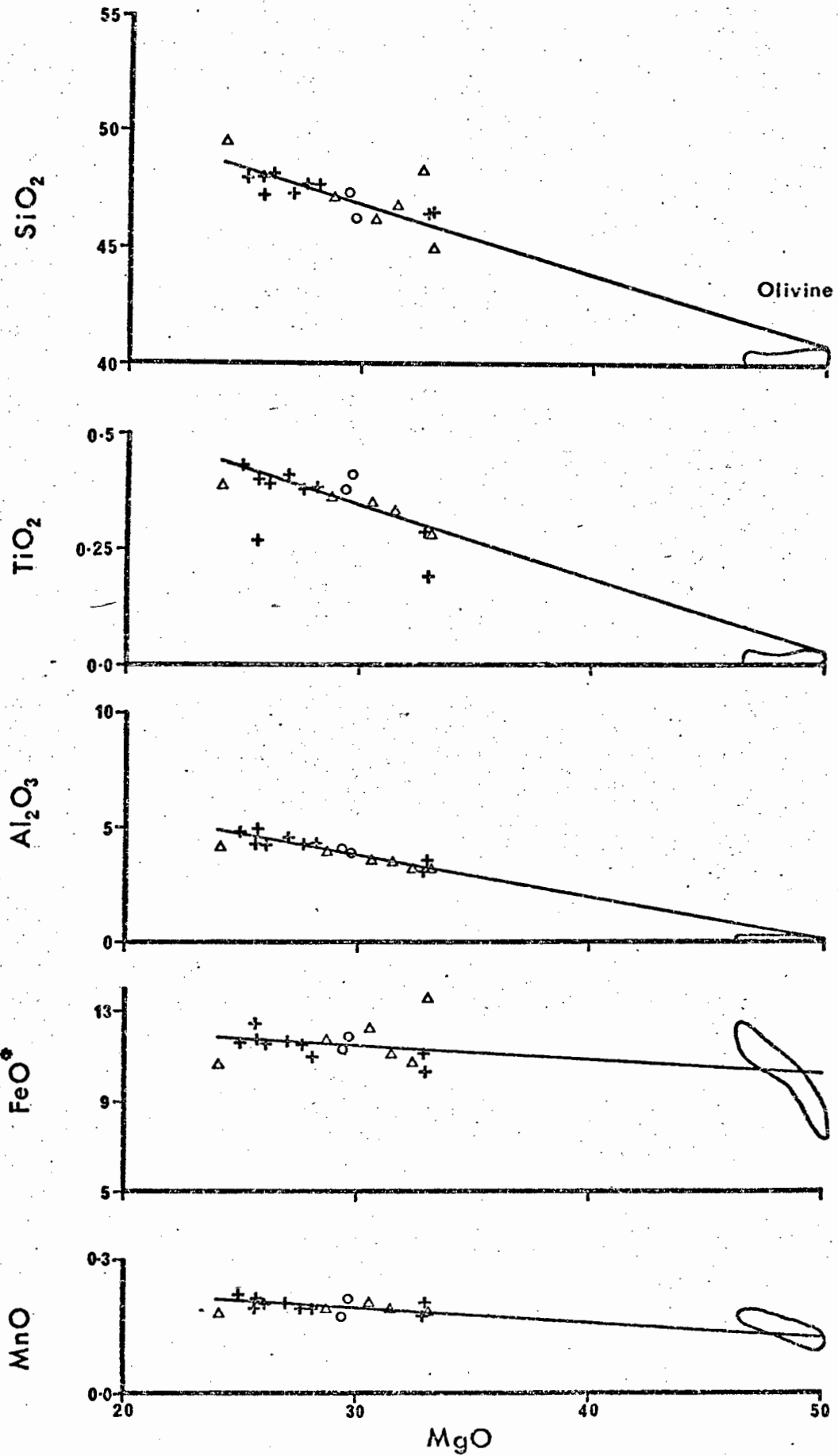


Fig. 5-8. Variations of major oxides (wt.%) and trace elements (ppm) with MgO content in the aphyric ultramafic komatiites from the LUU. FeO^* is total Fe expressed as FeO .

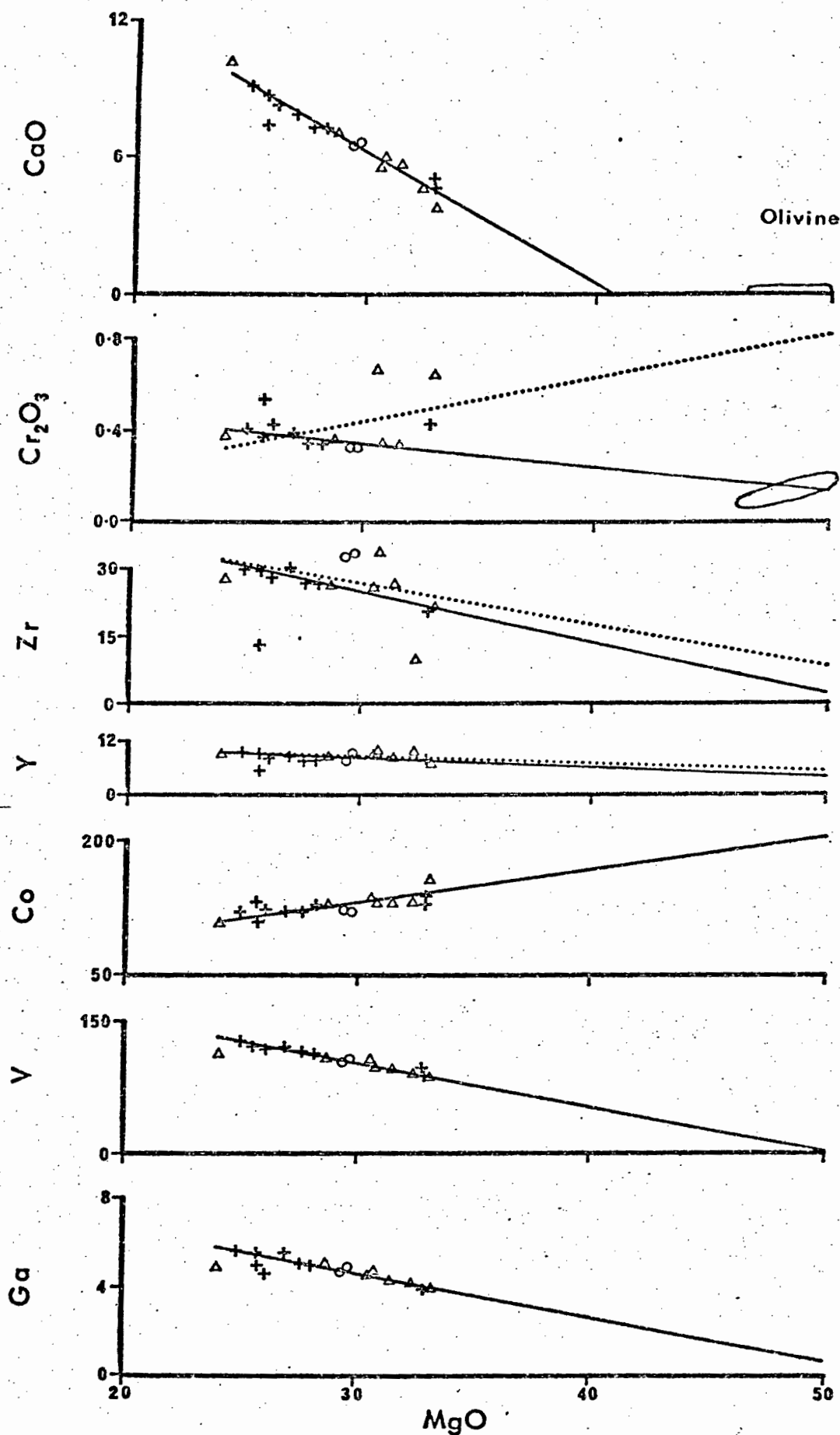


Fig. 5-8 (continued) The regression lines are for the group II lavas. Samples used to compute the solid and dotted regression lines are given in Table 5-7. Triangles are chilled margin samples, crosses are olivine spinifex textured samples and circles are pillow lava samples.

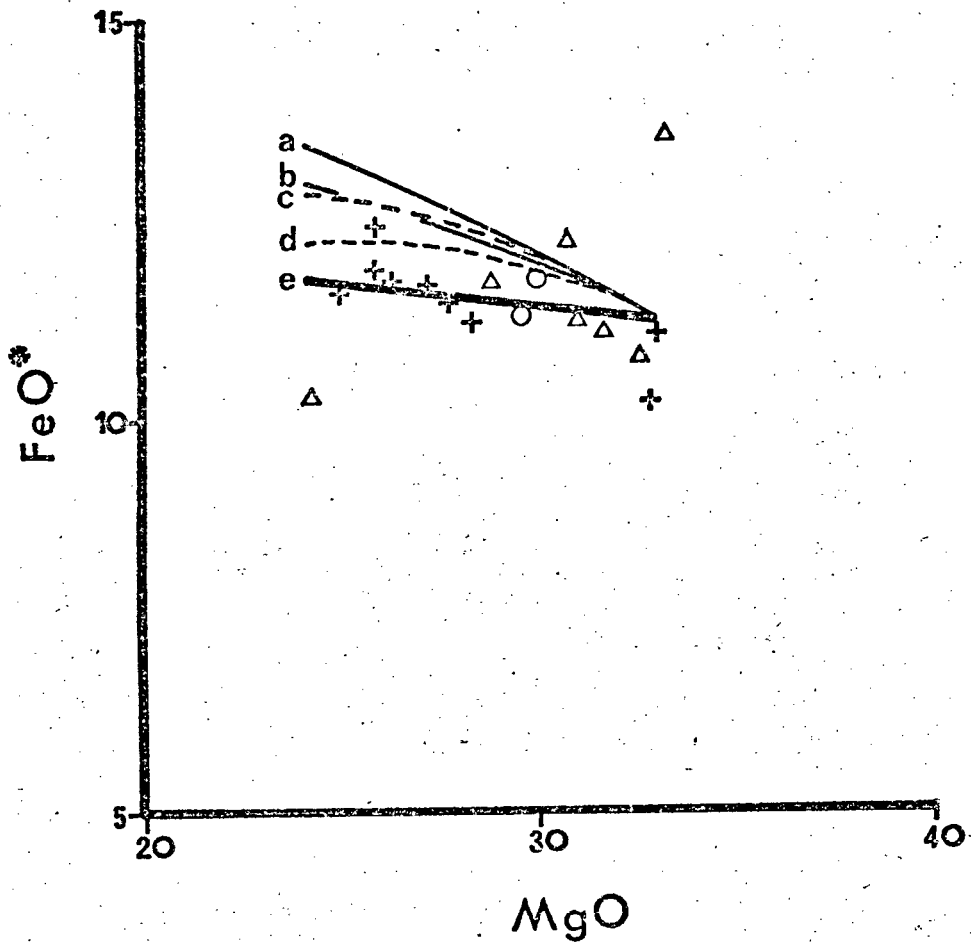


Fig. 5-9. Predicted residual liquid trends obtained from the crystallisation of olivine from a 33% MgO parent liquid. FeO* is total Fe expressed as FeO. Symbols as in Fig. 5-8. Lines a and b obtained assuming fractional crystallisation of olivine and K_D 's of 0.30 and 0.37 respectively. Lines c and d obtained assuming equilibrium crystallisation of olivine and K_D 's of 0.30 and 0.37 respectively. Line e is the regression trend from Fig. 5-8.

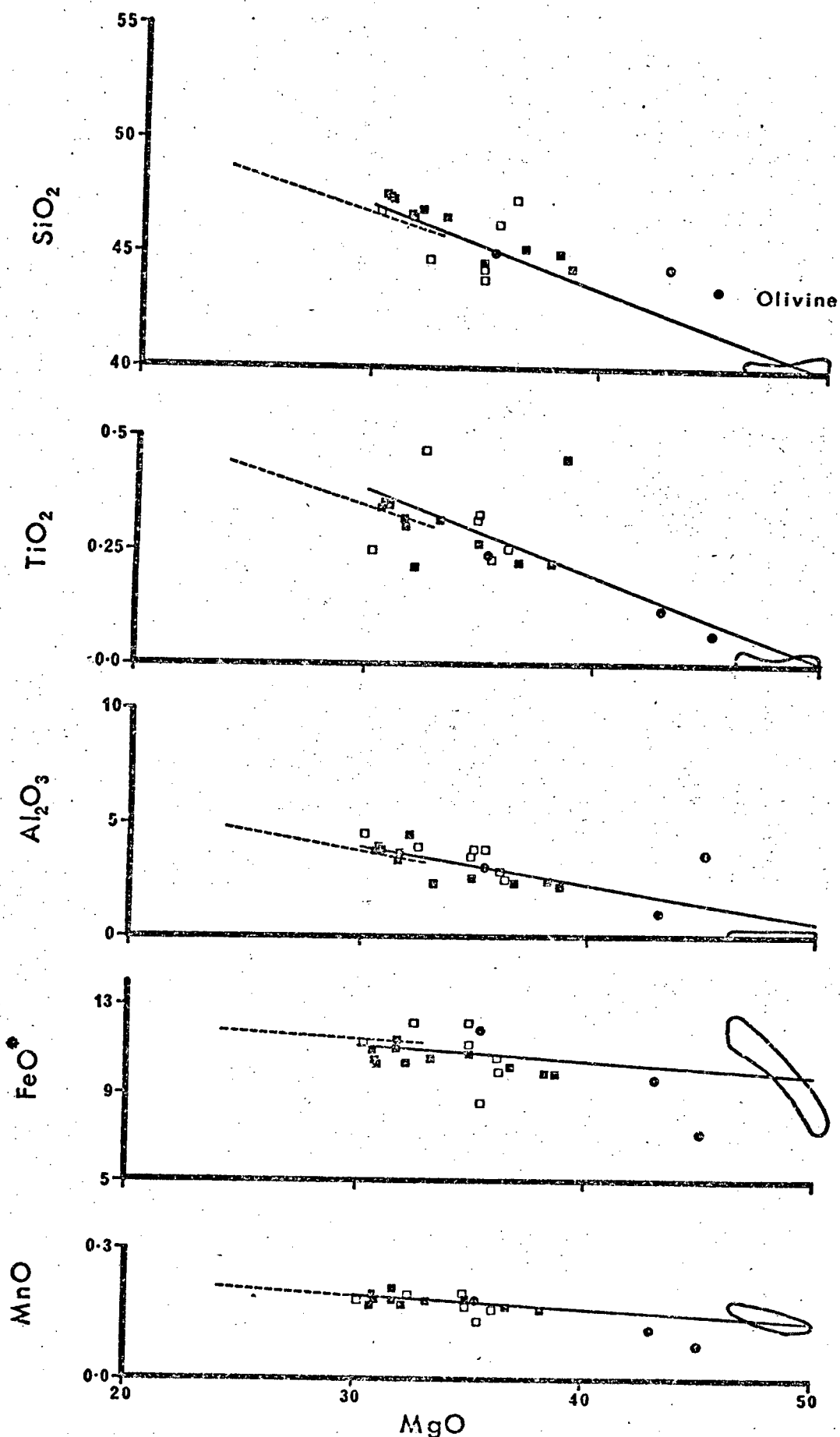


Fig. 5-10. Variations of major oxides (wt.%) and trace elements (ppm) with MgO content in the porphyritic ultramafic komatiites from the LUU. FeO[•] is total Fe expressed as FeO. The solid and dotted lines are regression

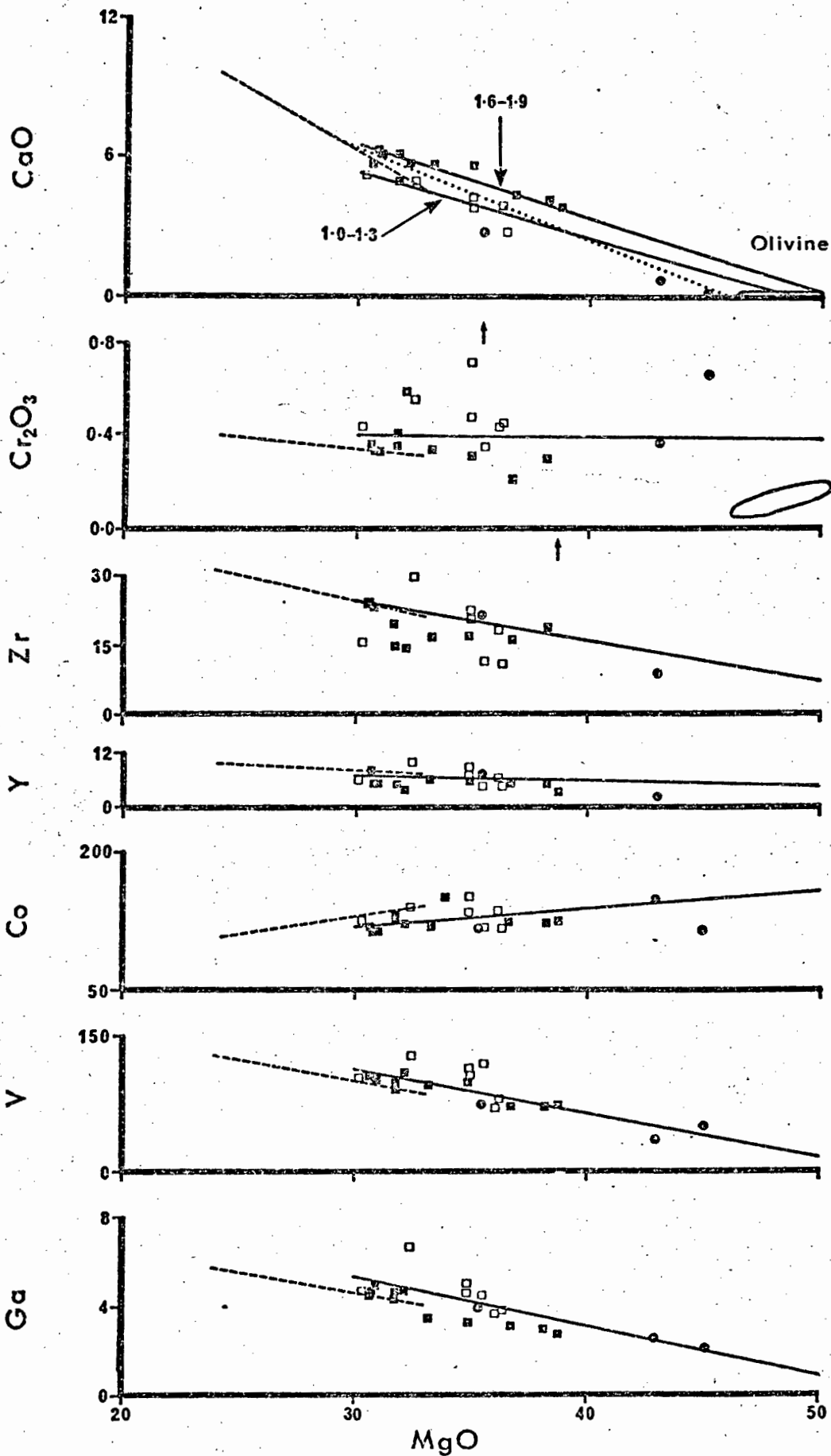


Fig. 5-10 (Continued) lines for the group II lavas and the dashed lines are the group II aphyric lava trends from Fig. 5-8. Open squares are olivine phyrlic samples, dots are olivine rich samples and filled squares are olivine-clinopyroxene phyrlic sample

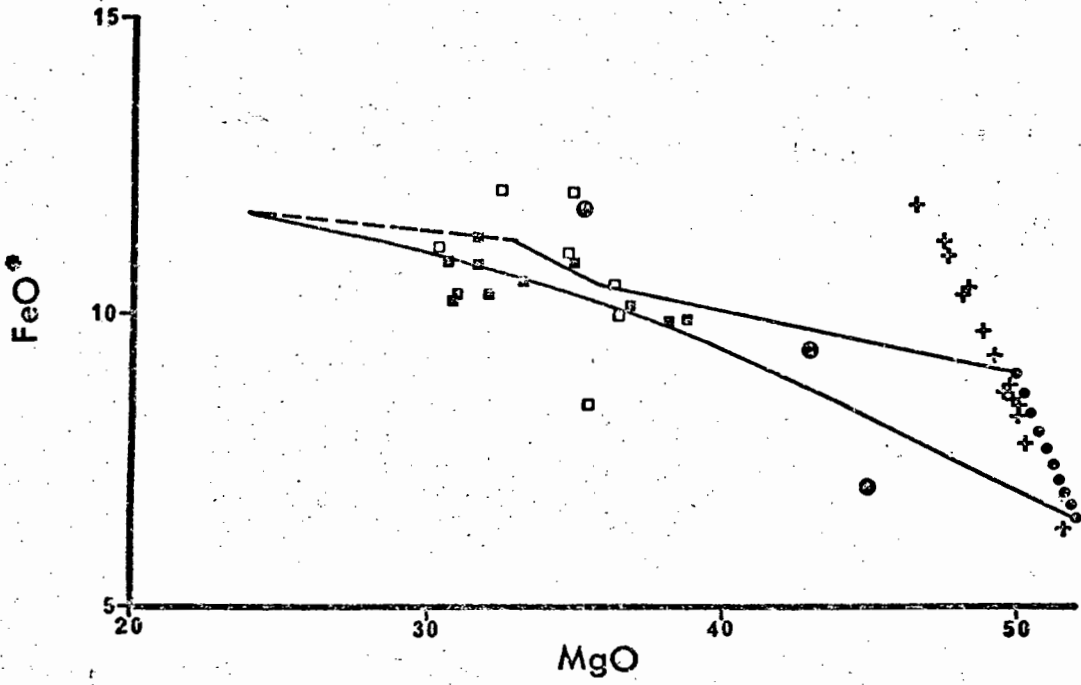


Fig. 5-11. FeO° (total Fe as FeO)- MgO variations (wt.%) for porphyritic ultramafic komatiites in relation to the field of possible partial cumulate compositions (outlined). Ornamentation as in Fig. 5-10. Small dots represent calculated olivine compositions and crosses are determined olivine compositions.

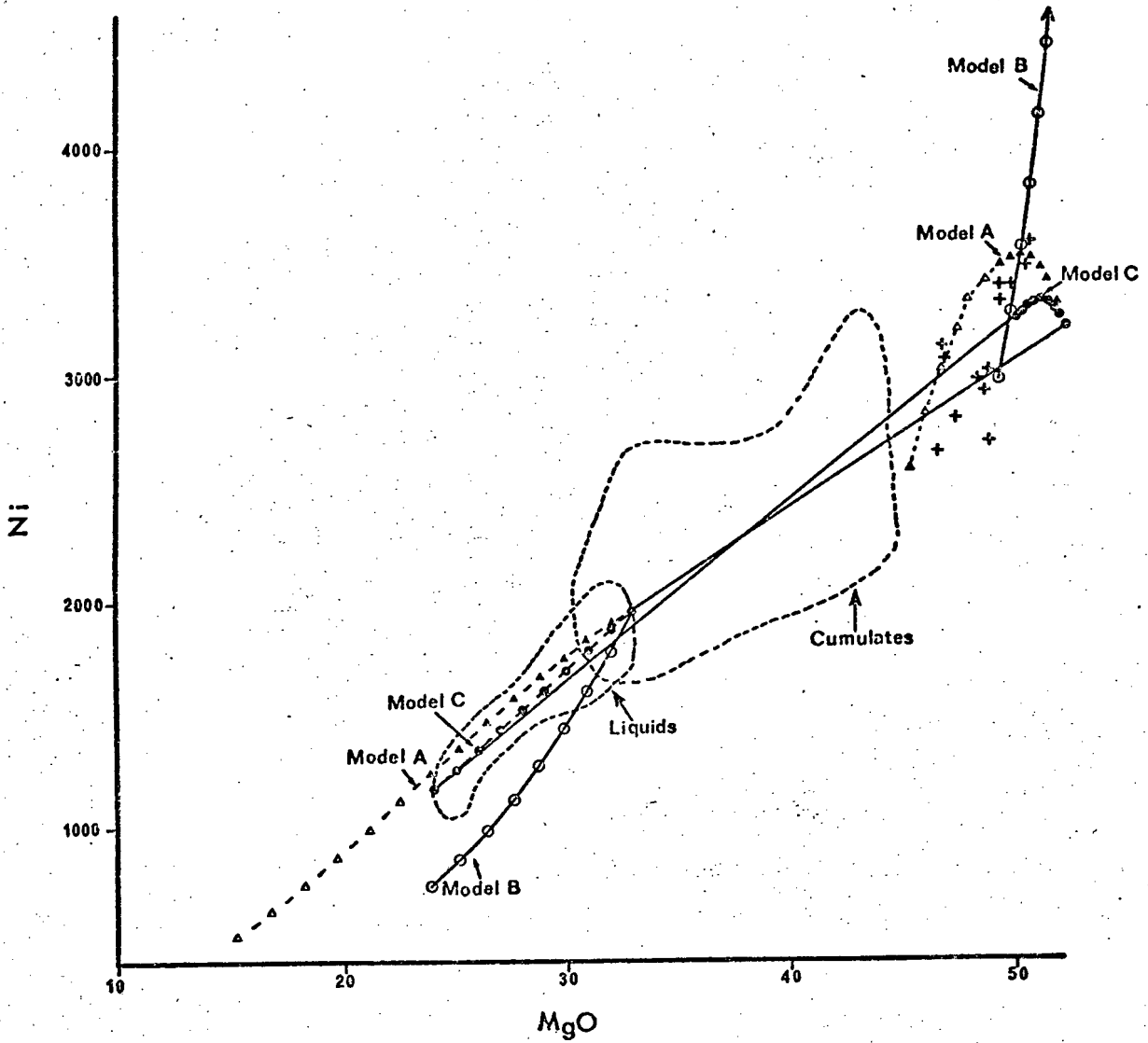


Fig. 5-12. Ni (ppm)-MgO (wt.%) variations in the LUU ultramafic komatiites. The fields occupied by the aphyric lavas (liquids) and the porphyritic samples (cumulates) are outlined. The crosses represent determined olivine compositions. See text for discussion of models A, B and C trend lines.

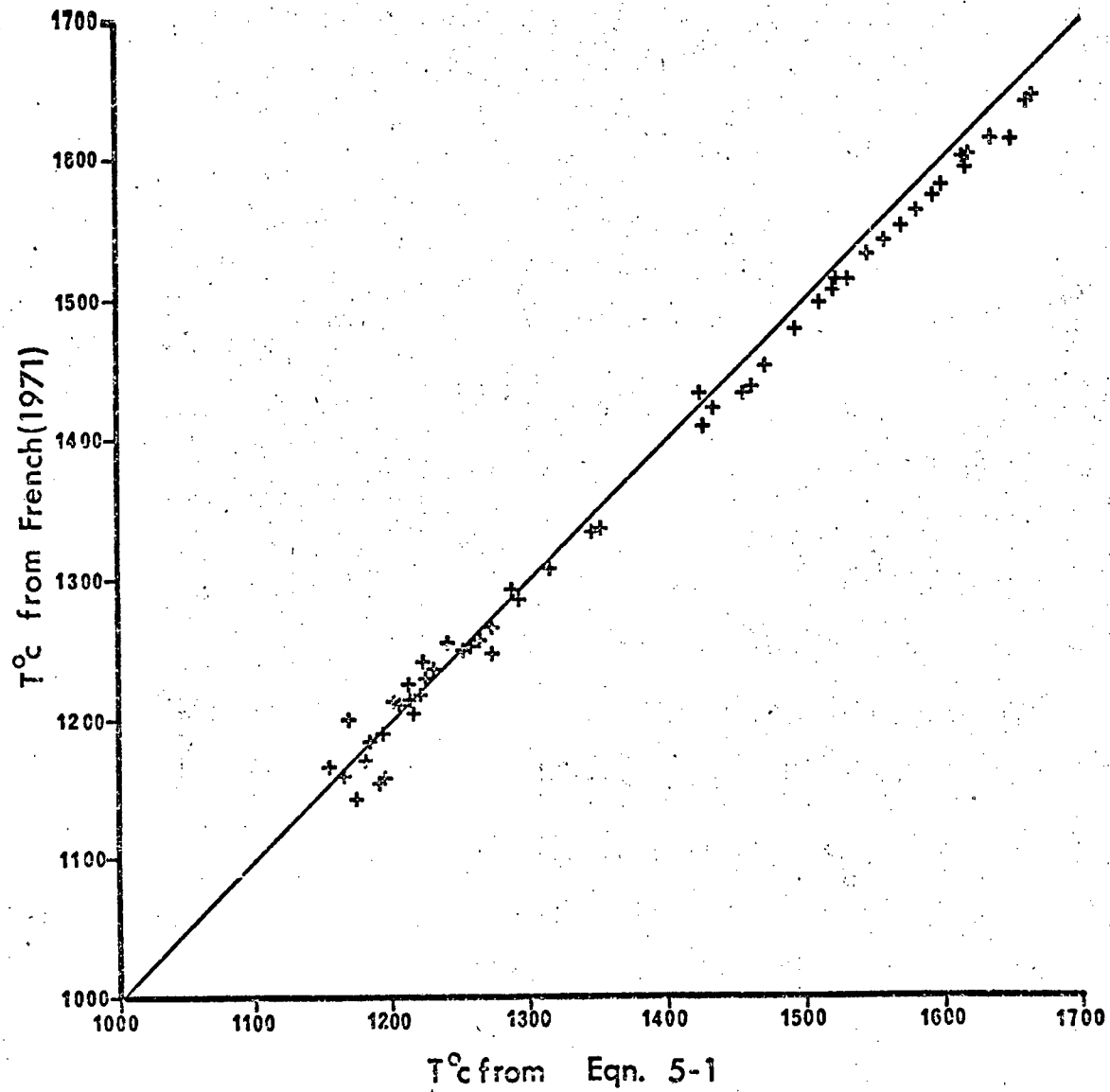


Fig. 5-13. One atmosphere liquidus temperatures obtained for komatiite lavas (9-33% MgO) using the equations derived by French (1971) and equation 5-1 in text.

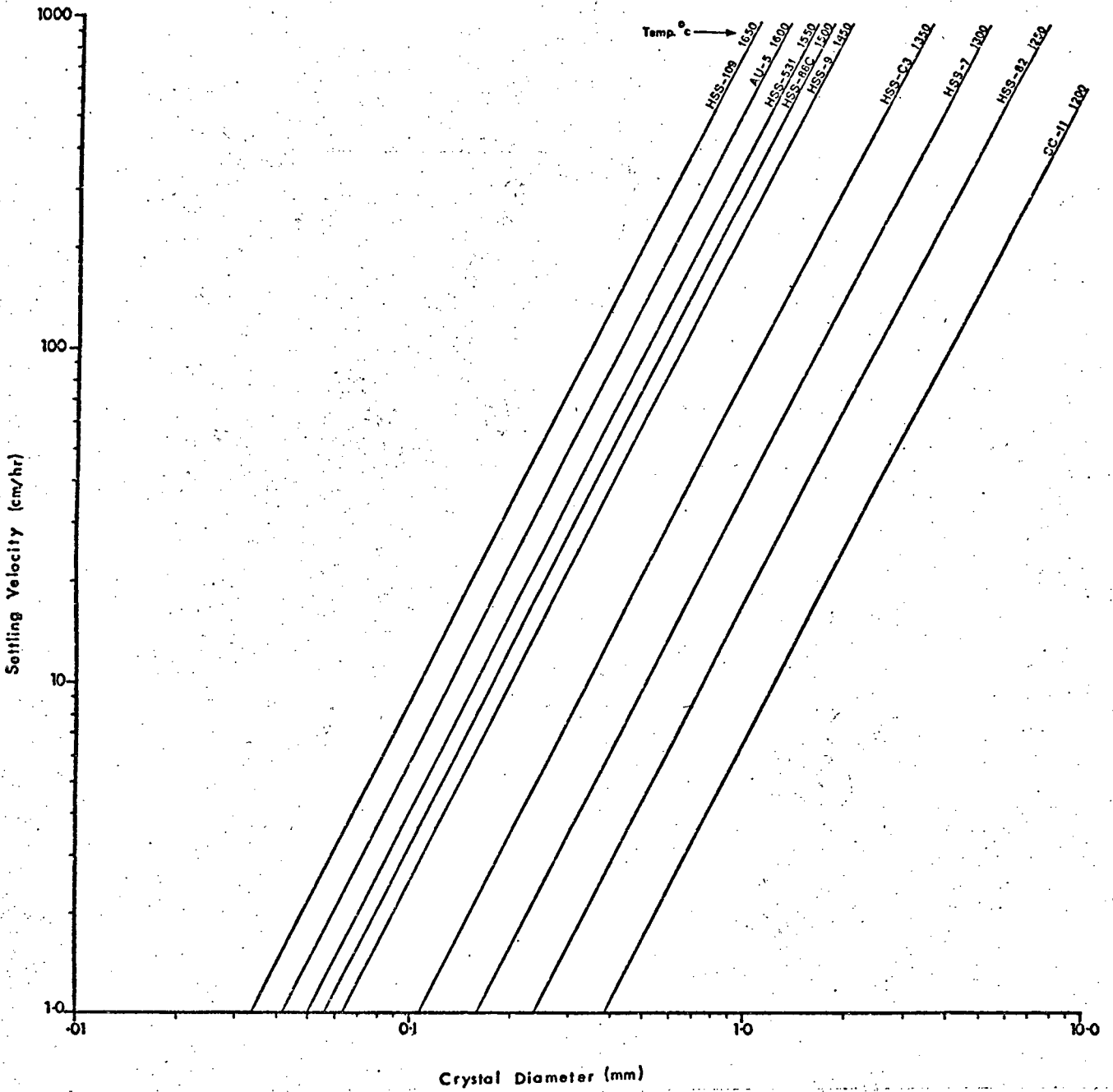


Fig. 5-14. Modelled olivine phenocryst settling rates in some aphyric komatiite lavas (9-33% MgO) that are considered to represent phenocryst free magma compositions.

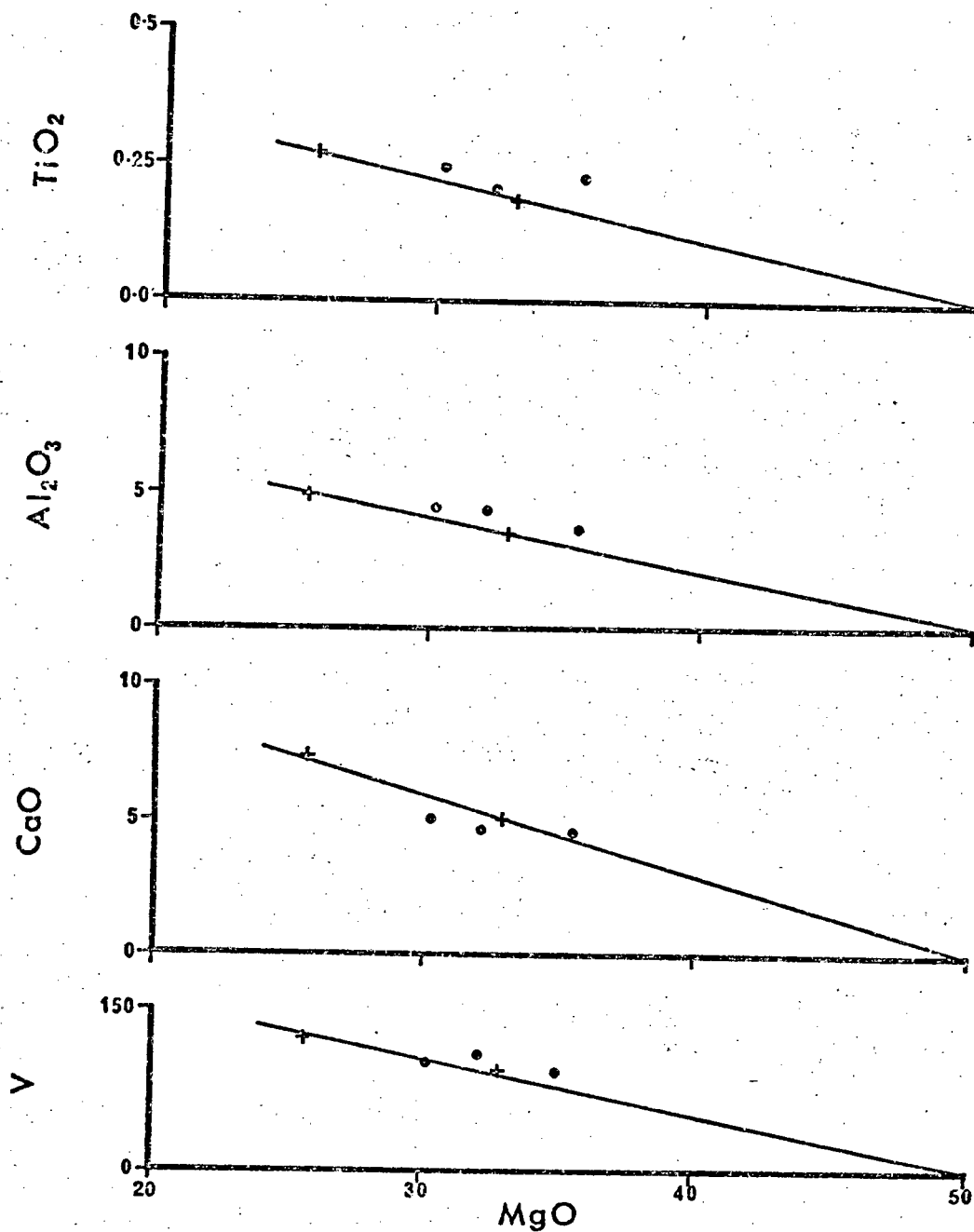


Fig. 5-15. Plot of selected oxides (wt.%) and trace elements (ppm) against MgO content of the group I ultramafic komatiites from the LUU. Olivine spinifex textured samples as crosses and porphyritic samples as dots. An olivine control line (24-50% MgO) has been drawn to pass through the two spinifex textured samples.

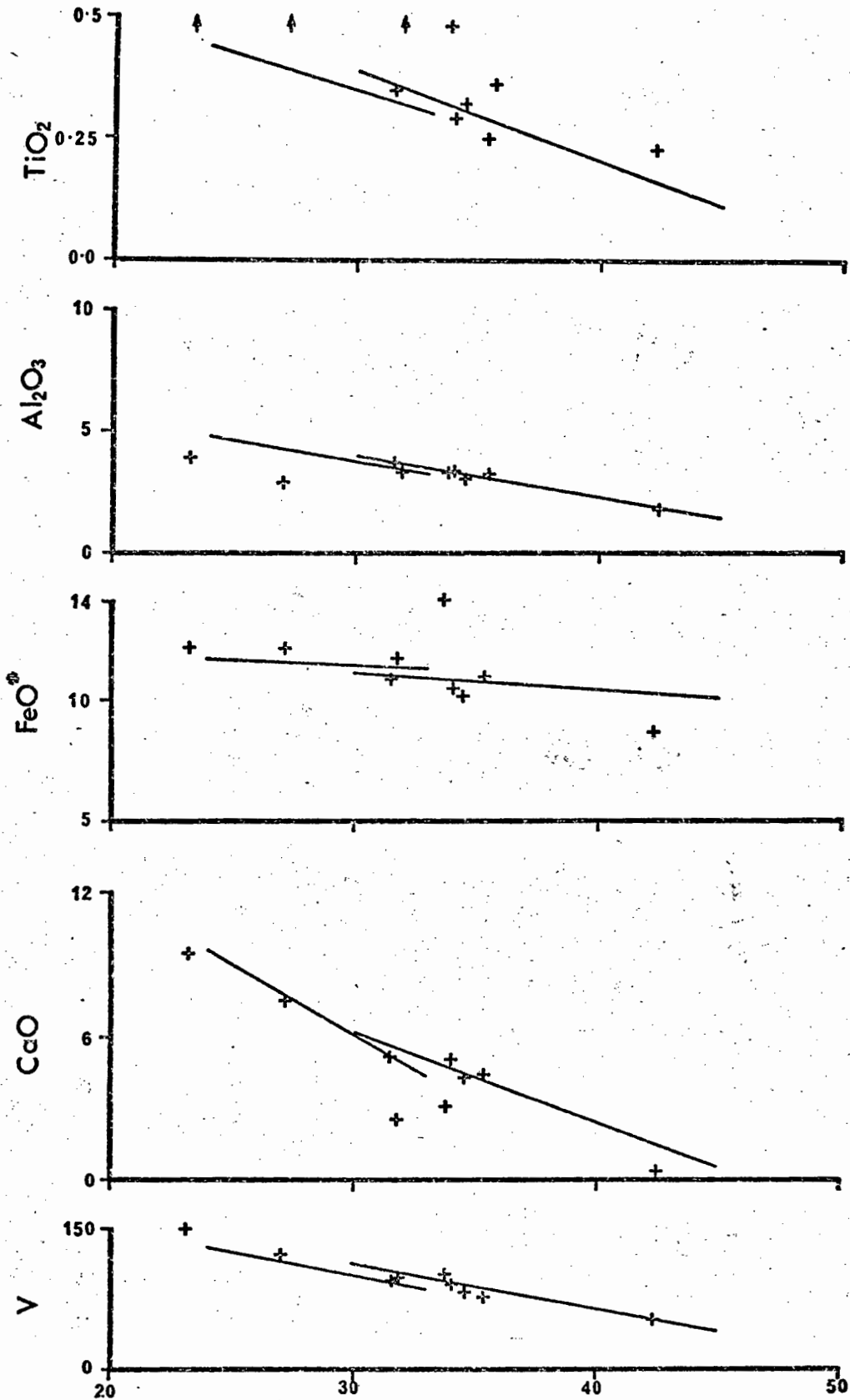


Fig. 5-16. Comparison of compositions (oxides in wt.%, elements in ppm) between the texturally altered ultramafic komatiites from the Sand-spruit Formation (crosses) and the group II aphyric (24-33% MgO trend line) and porphyritic (30-45% MgO trend line) ultramafic komatiites mainly from the Komati Formation.

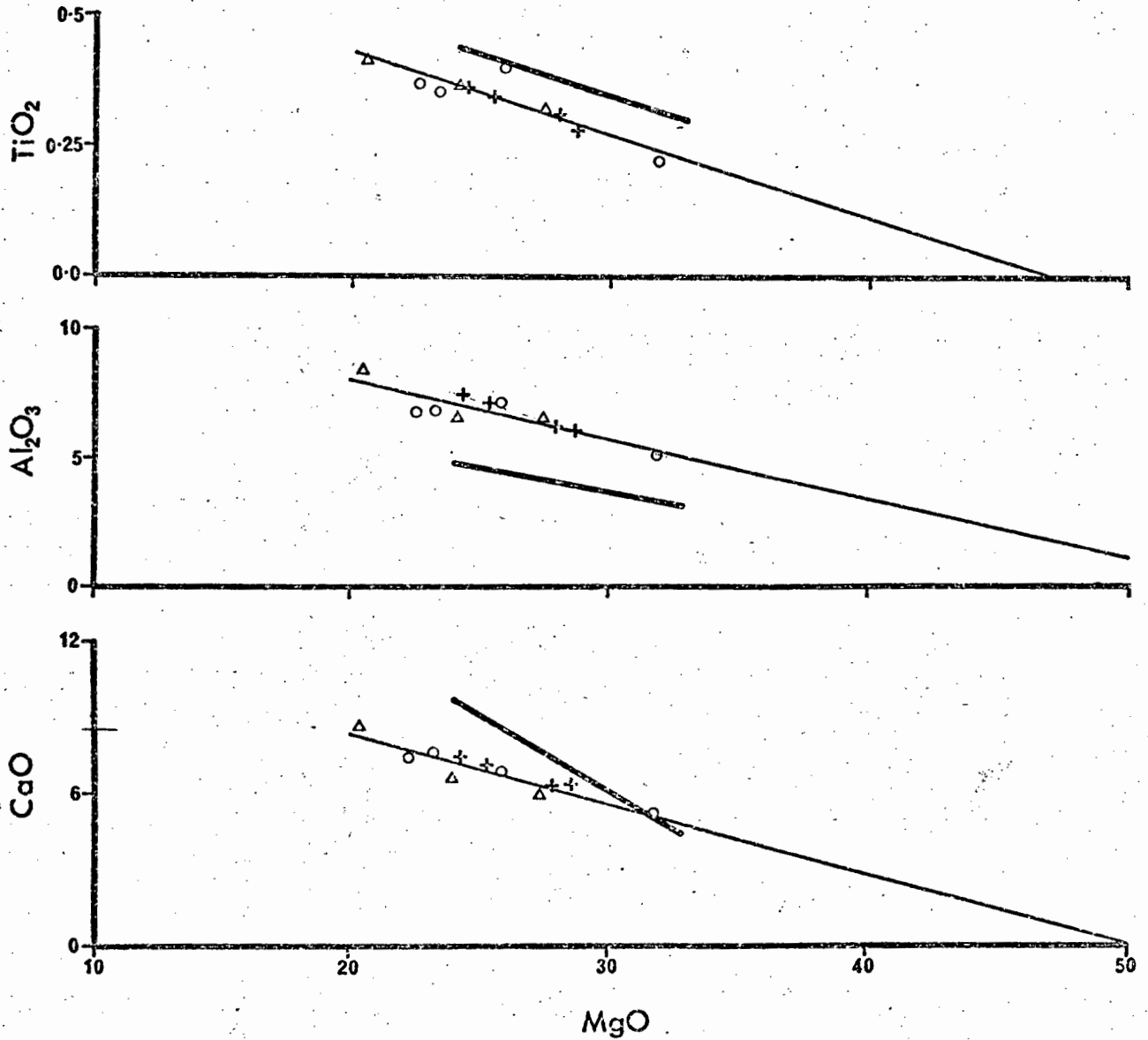


Fig. 5-17. Variations of composition (all oxides as wt.%) of selected Belingwe greenstone belt lavas (see Table 5-9 for sample nos.) compared to the trends (heavy line from 24-33% MgO) displayed by the LUU group II aphyric ultramafic komatiites. The equations of the regression lines fitted to the Belingwe data are given in Table 5-10.

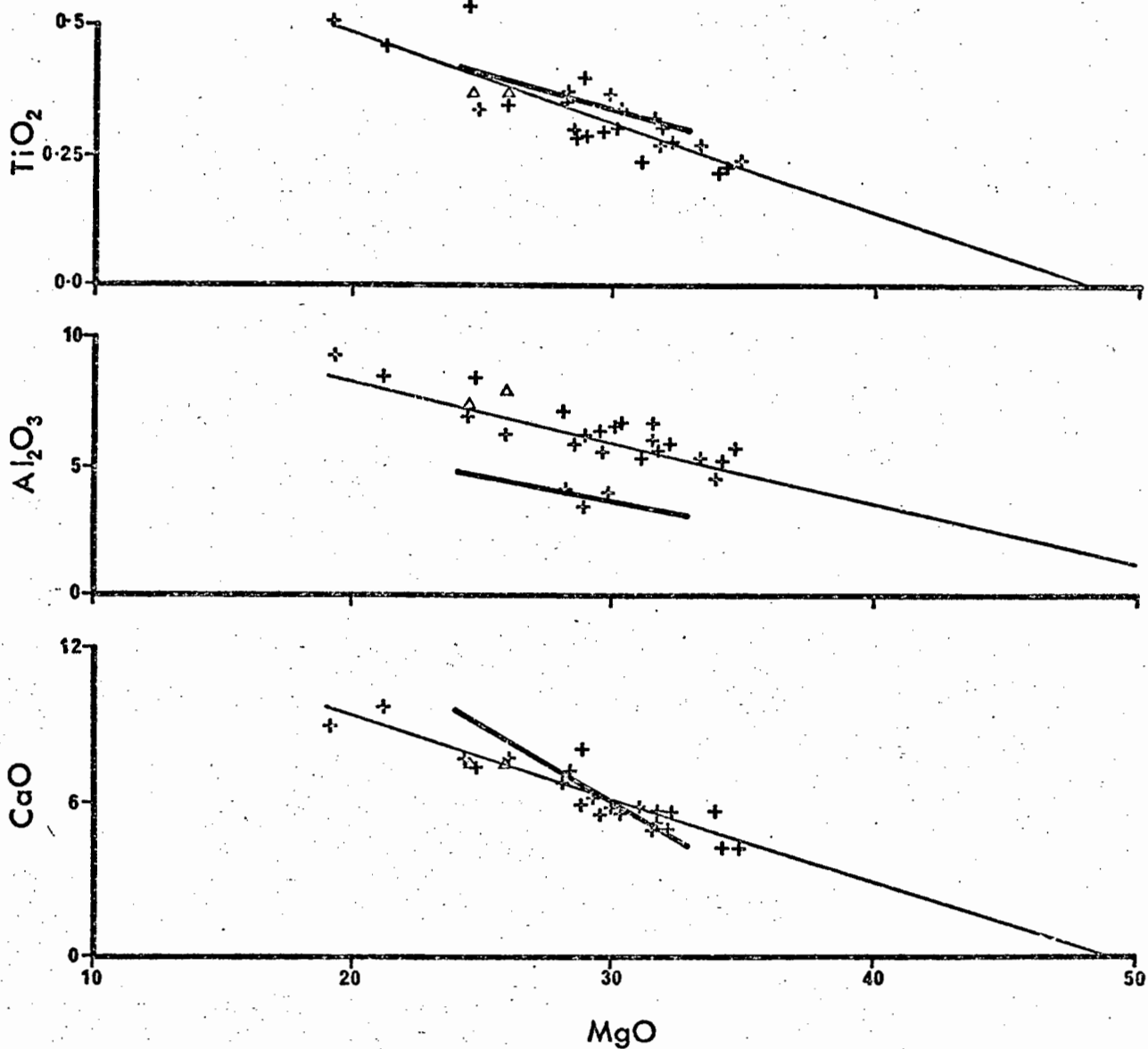


Fig. 5-18. Variations of composition (all oxides as wt.%) of selected Western Australian ultramafic komatiites (see Table 5-9 for sample nos.) compared to the trends (heavy line from 24-33% MgO) displayed by the LUU group II aphyric ultramafic komatiites. The equations of the regression lines fitted to the Western Australian data are given in Table 5-10.

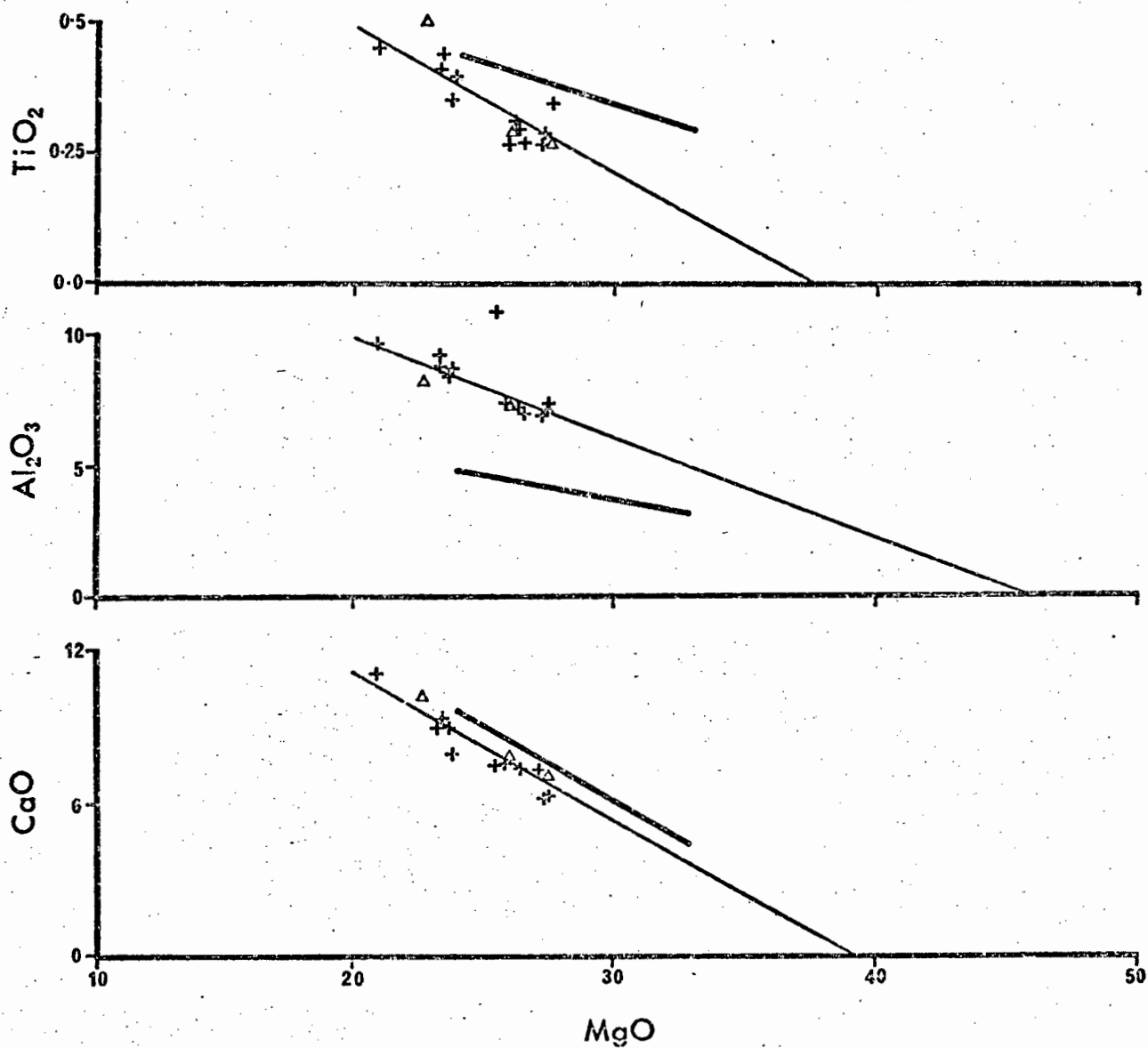


Fig. 5-19. Variations of composition (all oxides as wt.%) of selected Munro Township ultramafic komatiites (see Table 5-9 for sample nos.) compared to the trends (heavy line from 24-33% MgO) displayed by the LUU group II aphyric ultramafic komatiites. The equations of the regression lines fitted to the Munro Township data are given in Table 5-10.

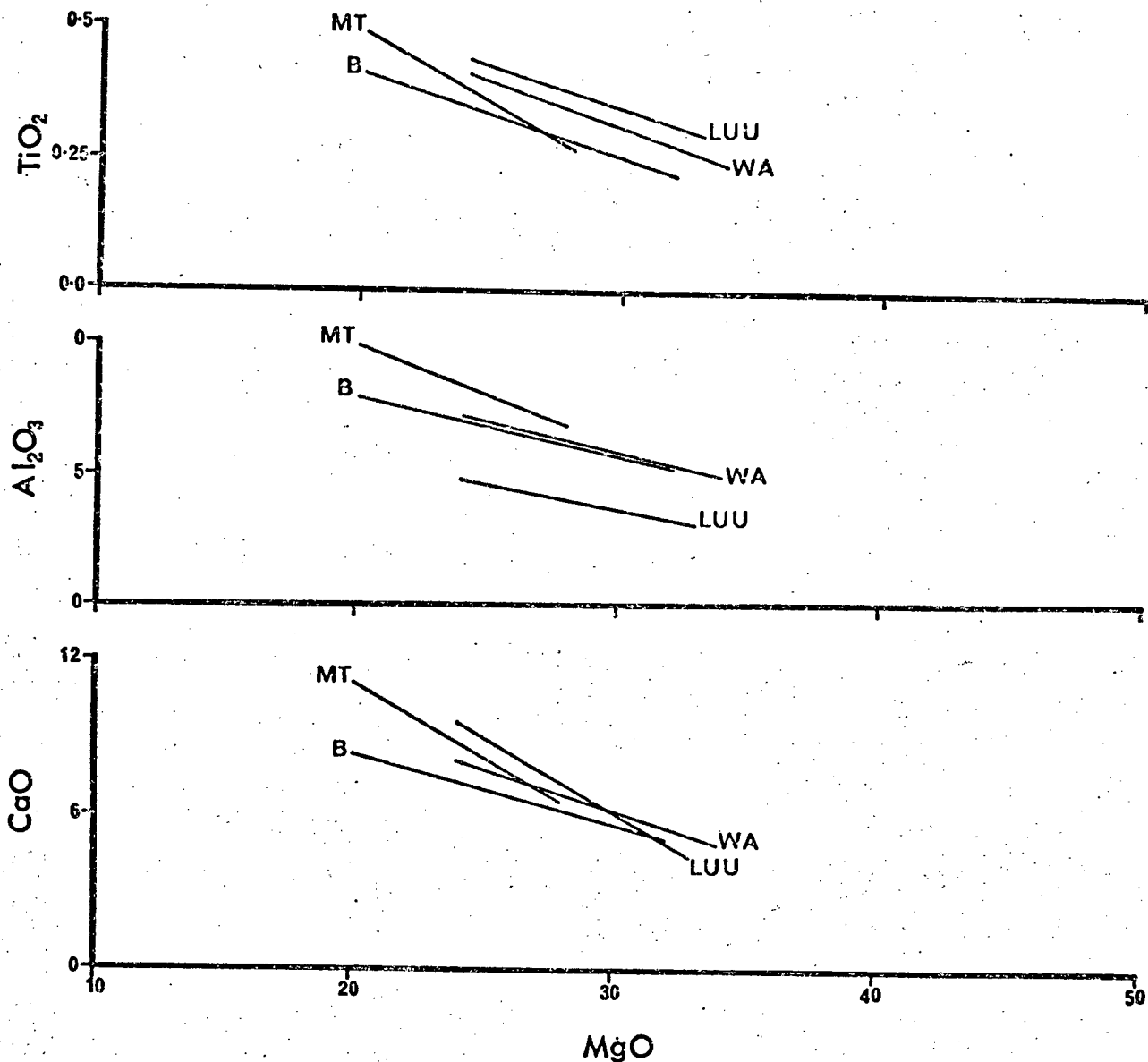


Fig. 5-20. Summary of the regression line trends obtained from the LUU, Belingwe (B), Western Australia (WA) and Munro Township (MT) ultramafic komatiites. The regression lines span the range of compositions that are considered to represent phenocryst free magma compositions from each area.

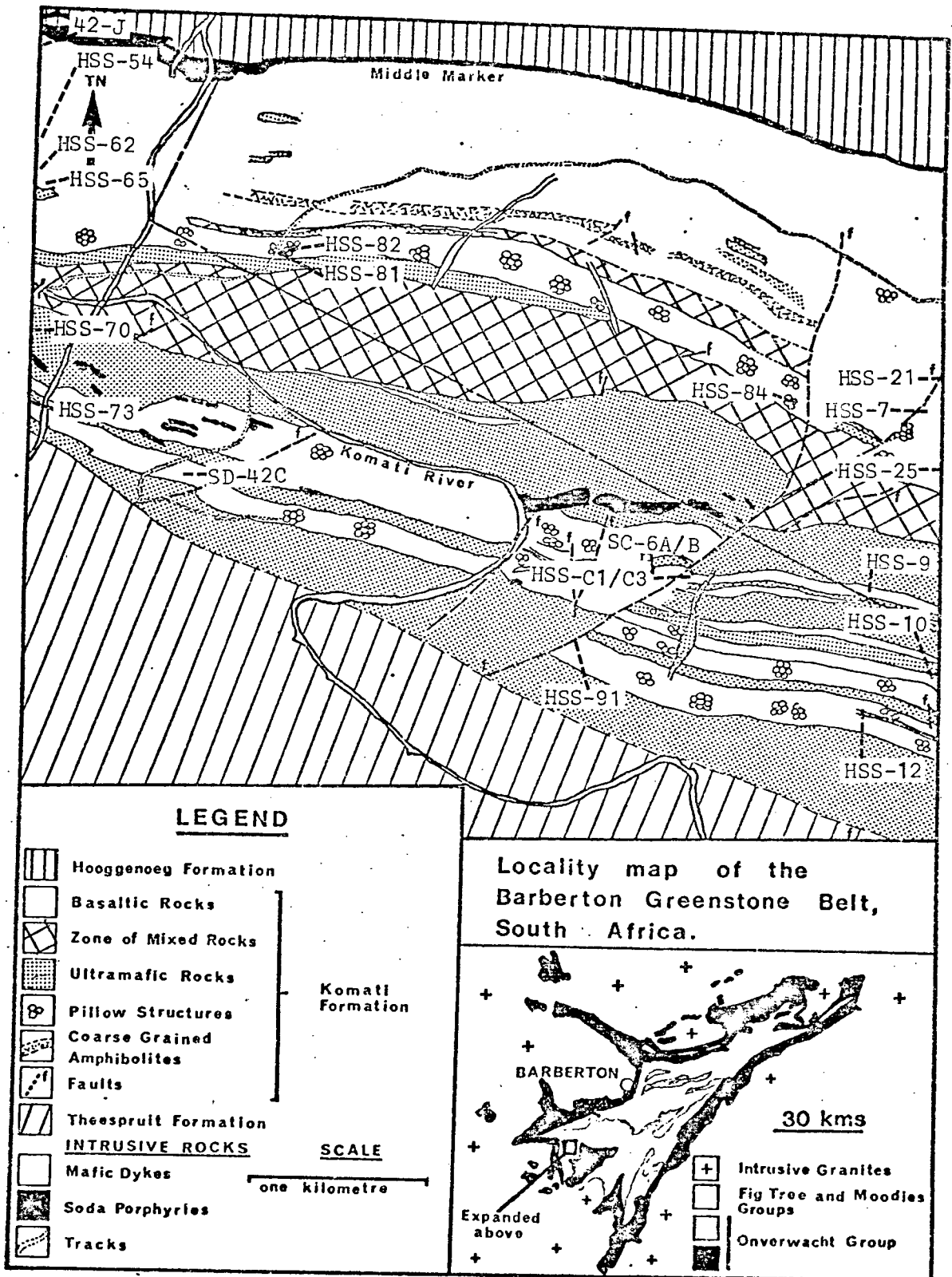


Fig. 6-1. A simplified geological map of the Komati Formation Type Area taken from Viljoen and Viljoen (1969c). The sample locations of the aphyric mafic komatiite lavas are shown.

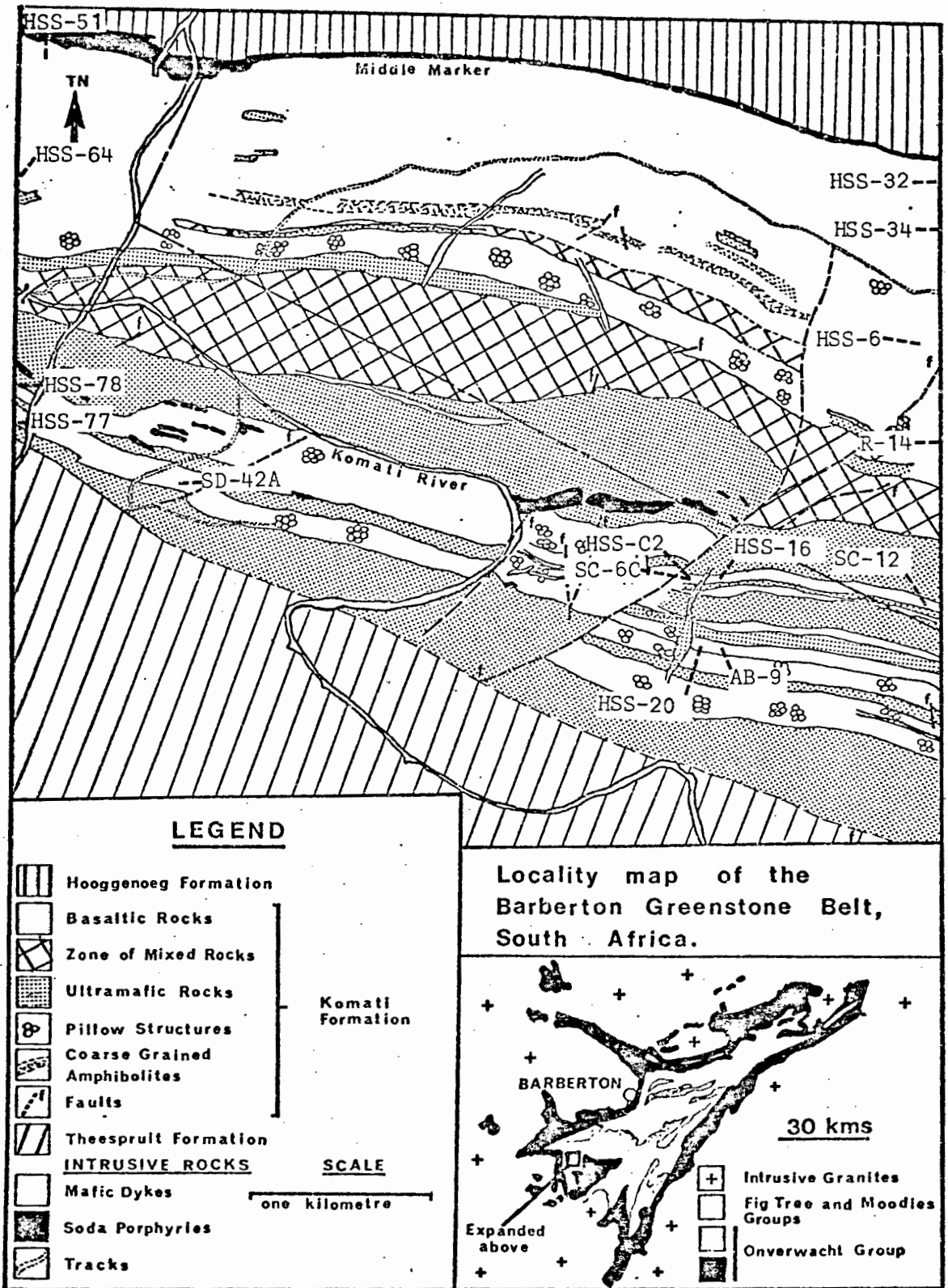


Fig. 6-2. A simplified geological map of the Komati Formation Type Area taken from Viljoen and Viljoen (1969c). The sample locations of the porphyritic mafic komatiite rocks are shown.

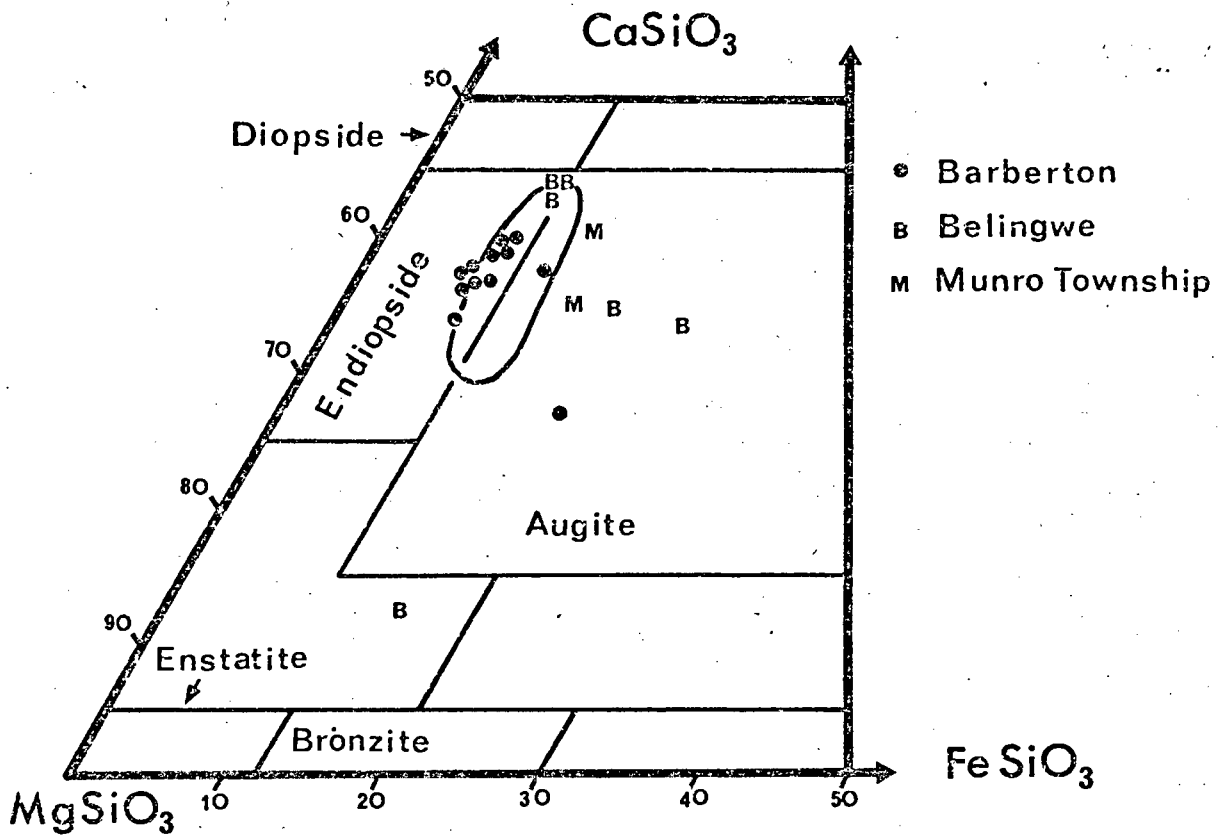


Fig. 6-3. Pyroxene compositions in the mafic komatiite lavas from the LUU compared to pyroxene compositions from similar lavas from Belingwe and Munro Township. The field of clinopyroxene compositions occurring in the LUU ultramafic lavas is outlined.

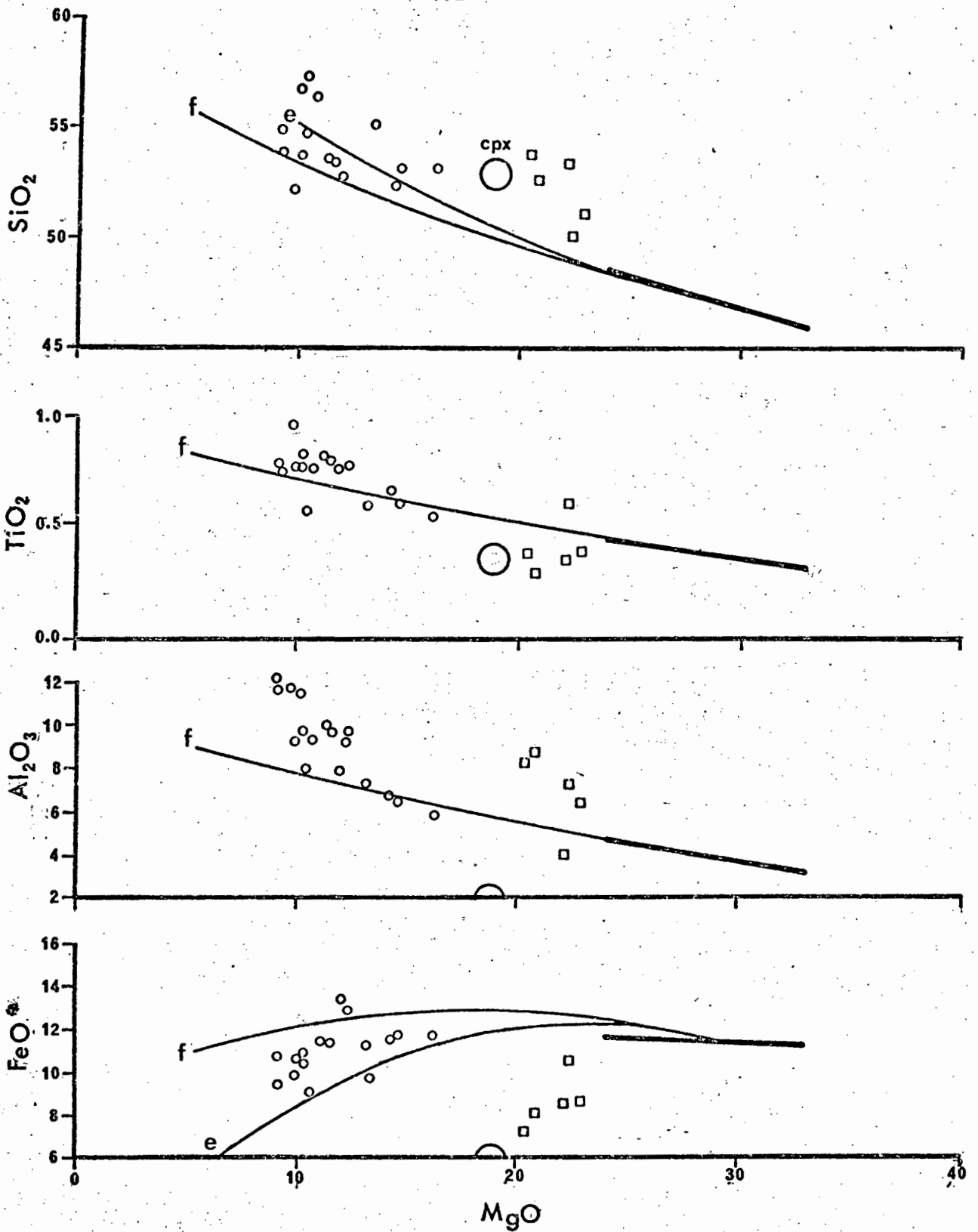


Fig. 6-4. Variations of major oxides (wt. %) and trace elements (ppm) with MgO content in the aphyric mafic komatiite lavas. FeO is total Fe expressed as FeO. High-Mg mafic komatiites as squares and low-Mg mafic komatiites as small circles. The large circle represents the average clinopyroxene composition in the mafic komatiites. The trends of the aphyric

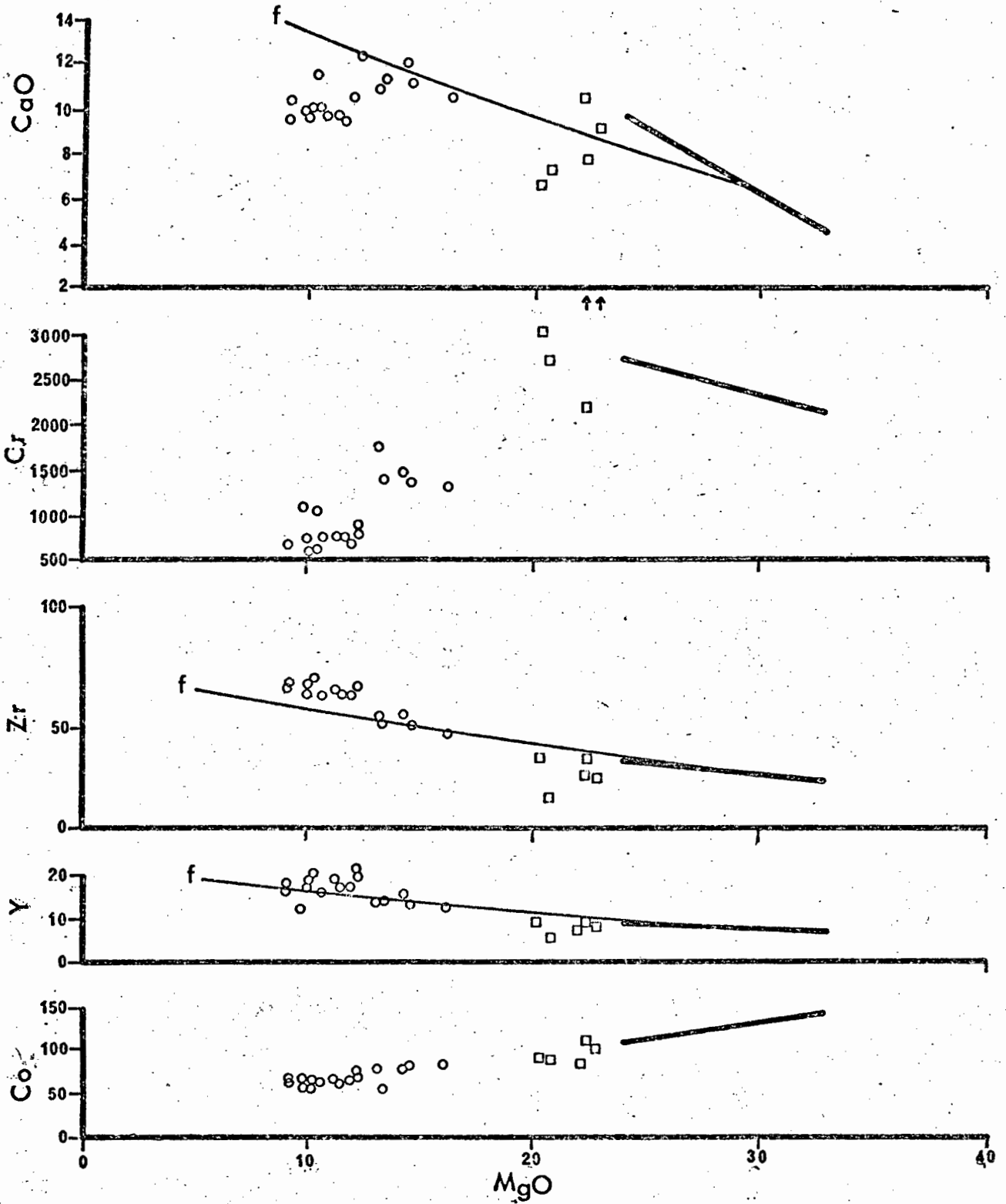


Fig. 6-4 (Continued) ultramafic komatiites (group II) from 24-33% MgO are shown (heavy line), as well as the fractional (f) and equilibrium (e) crystallisation paths generated by olivine crystallisation from the average aphyric ultramafic komatiite lava (group II).

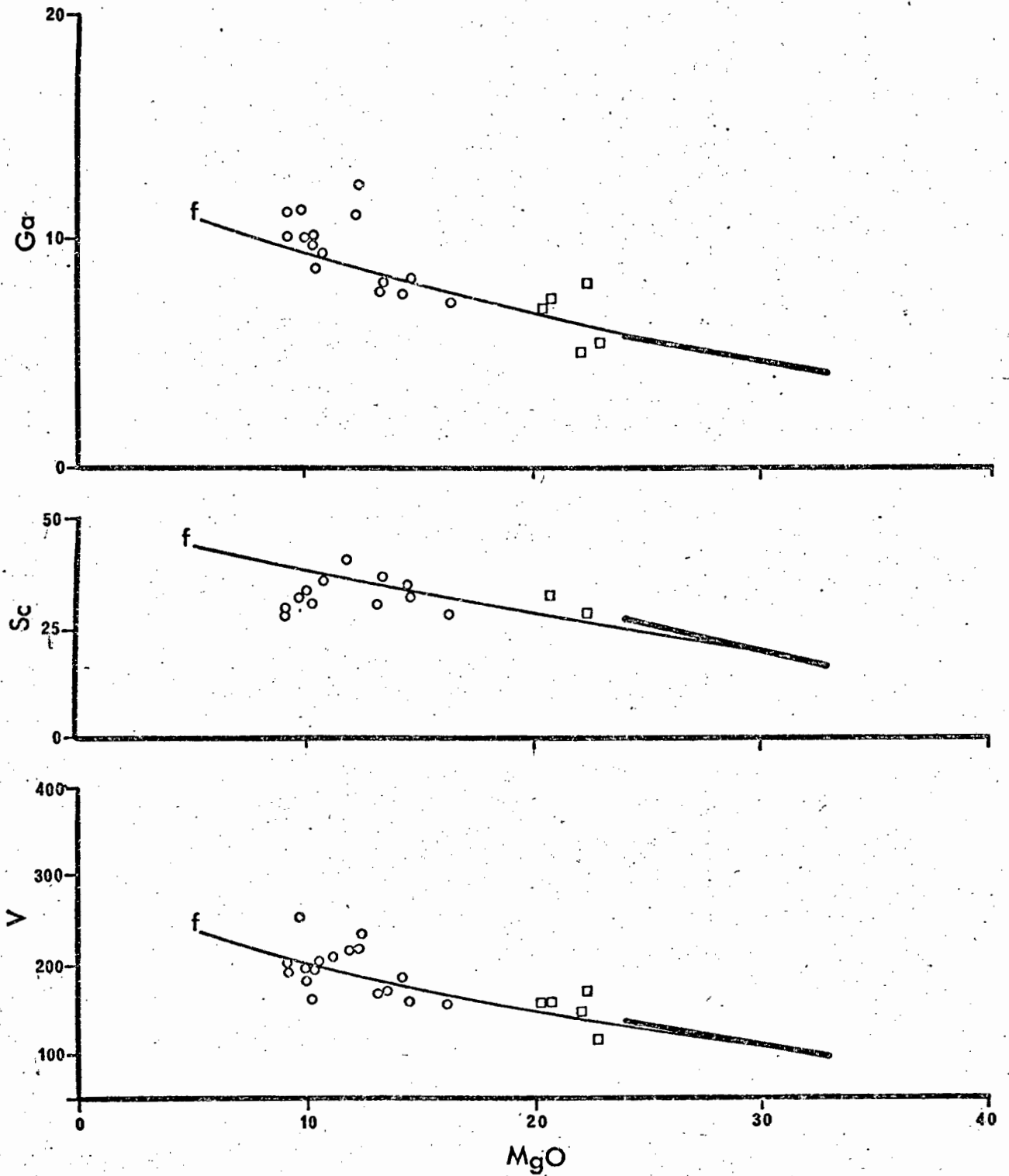


Fig. 6-4 (Continued)

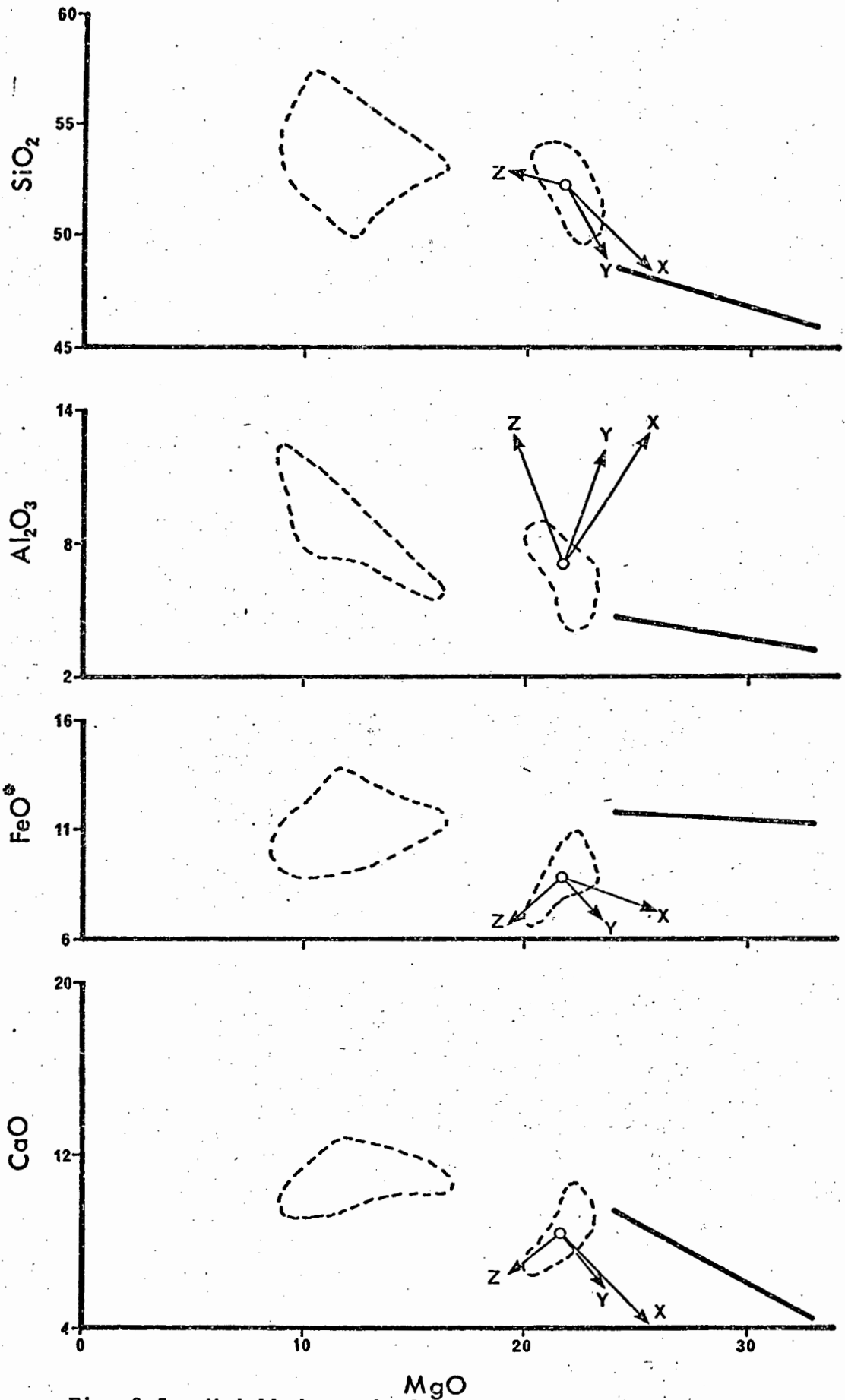


Fig. 6-5. Modelled trends for the aphyric high-Mg mafic komatiites. The dashed fields represent the range of aphyric high-Mg and low-Mg mafic komatiite compositions and the heavy line represents the trends from the aphyric ultramafic komatiites (group II).

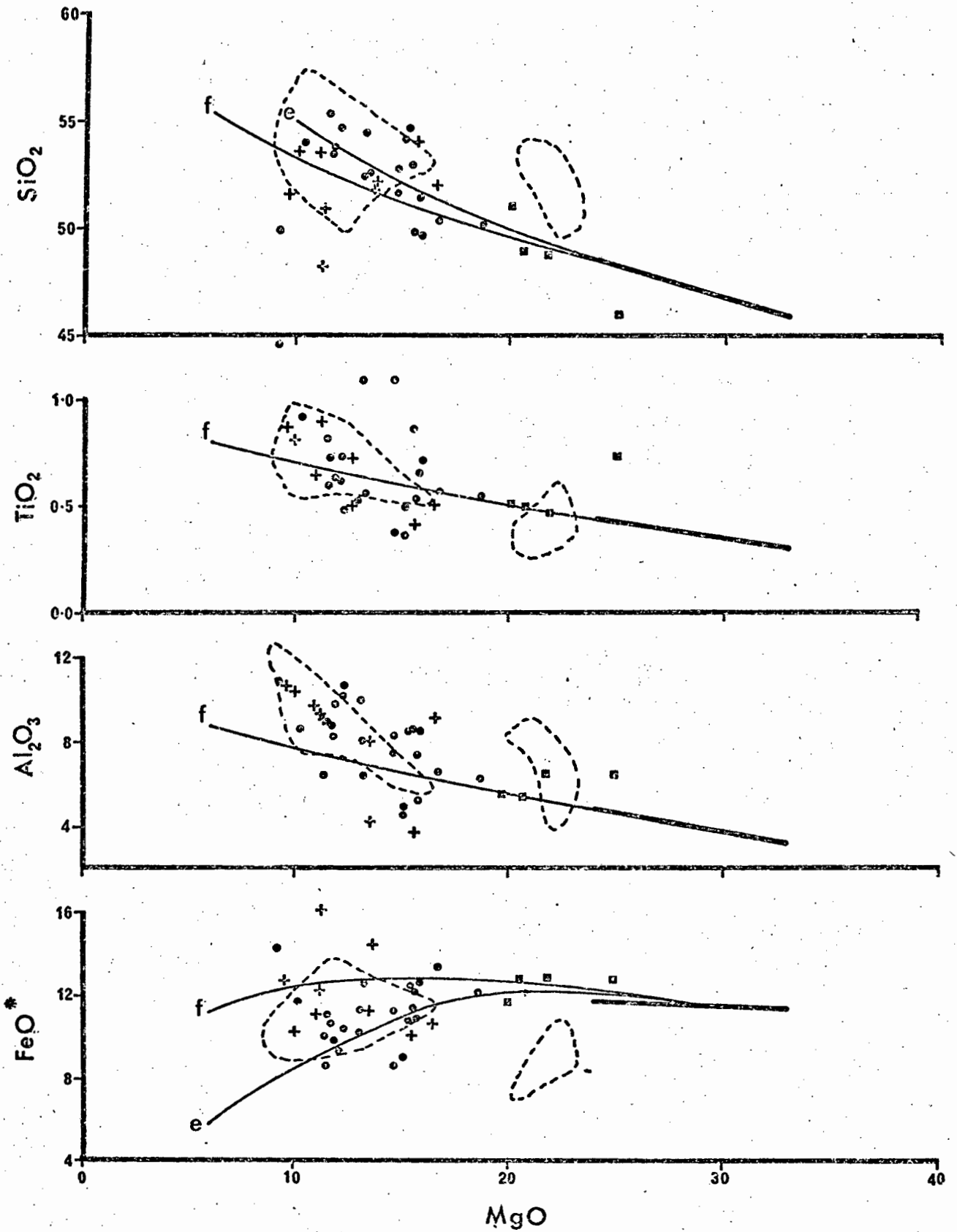


Fig. 6-6. Variations of major oxides (wt. %) and trace elements (ppm) with MgO content in the porphyritic and altered mafic komatiite lavas. FeO* is total Fe expressed as FeO. Porphyritic

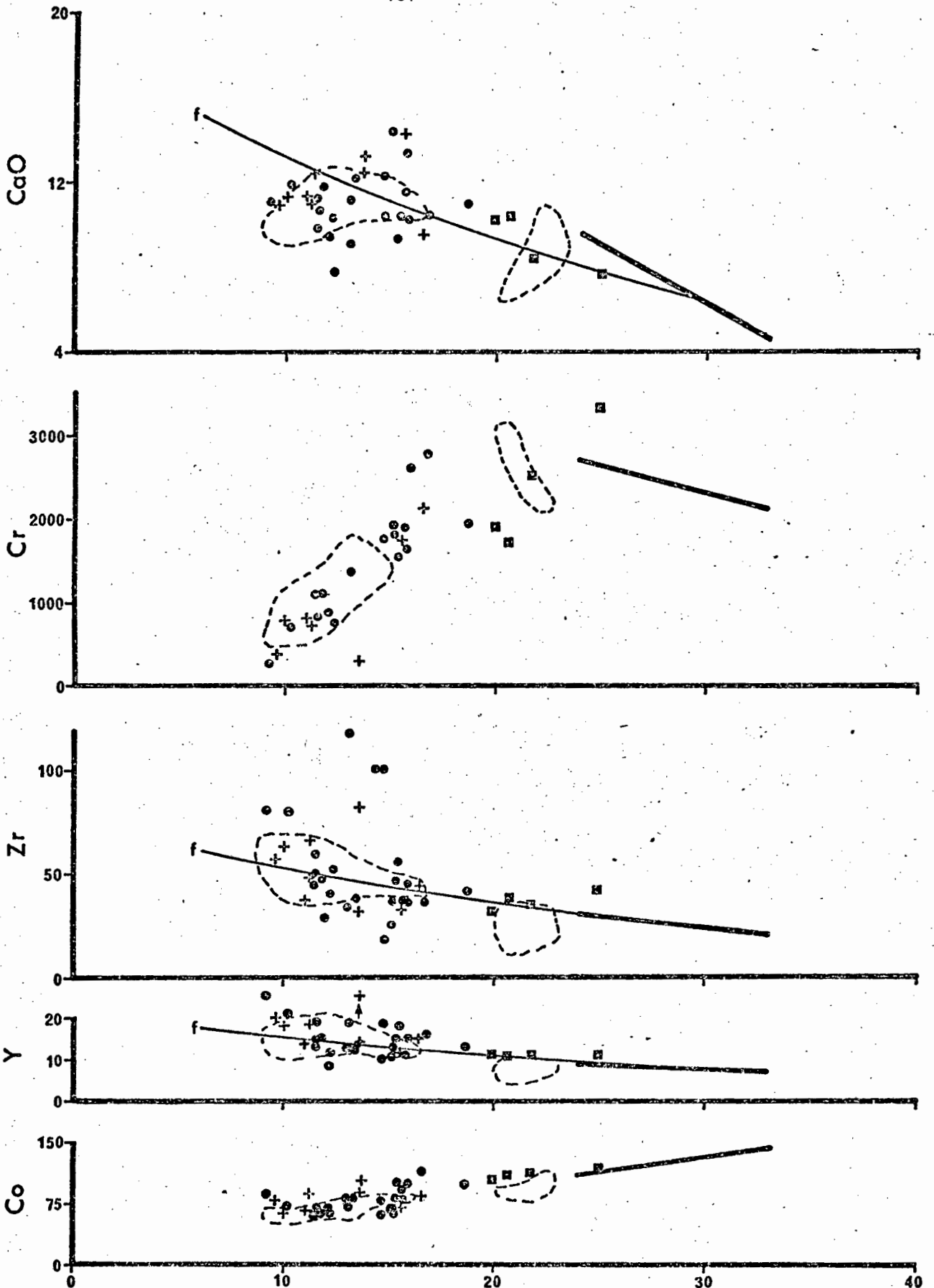


Fig. 6-6 (Continued) high - Mg mafic komatiites as filled squares, porphyritic low-Mg mafic komatiites as dots, altered mafic komatiites as crosses. See Fig. 6-4 for description of light and heavy

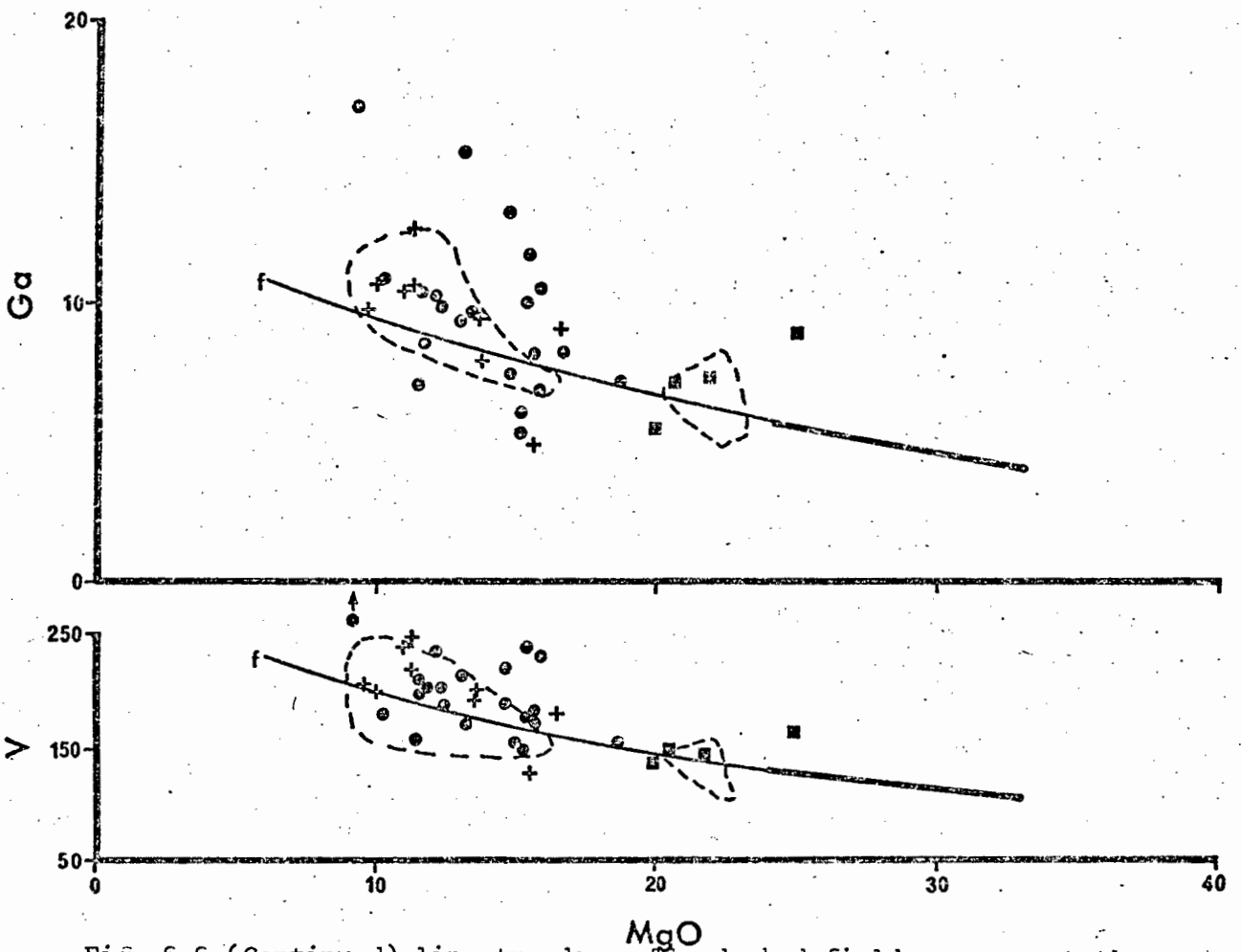


Fig. 6-6 (Continued) line trends.. The dashed fields represent the range of aphyric high-Mg and low-Mg mafic komatiites.

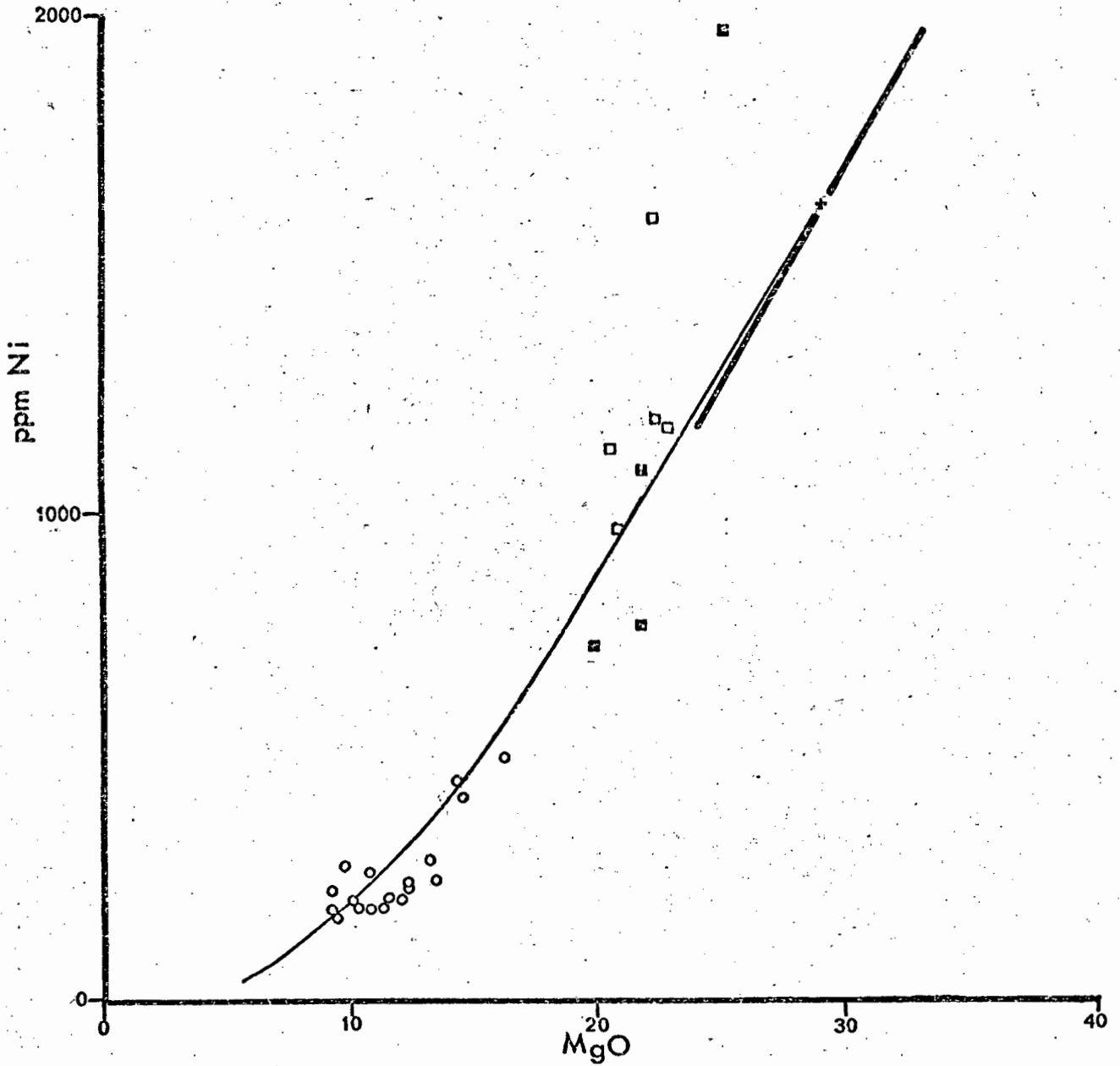


Fig. 6-7. Ni (ppm) and MgO (wt. %) variations in the mafic komatiites. Aphyric high-Mg mafic komatiites as squares, porphyritic high-Mg mafic komatiites as solid squares and aphyric low-Mg mafic komatiites as circles. The heavy line is the aphyric ultra-mafic komatiite trend and the light line represents the trend generated by fractional crystallisation of olivine (See text for discussion).

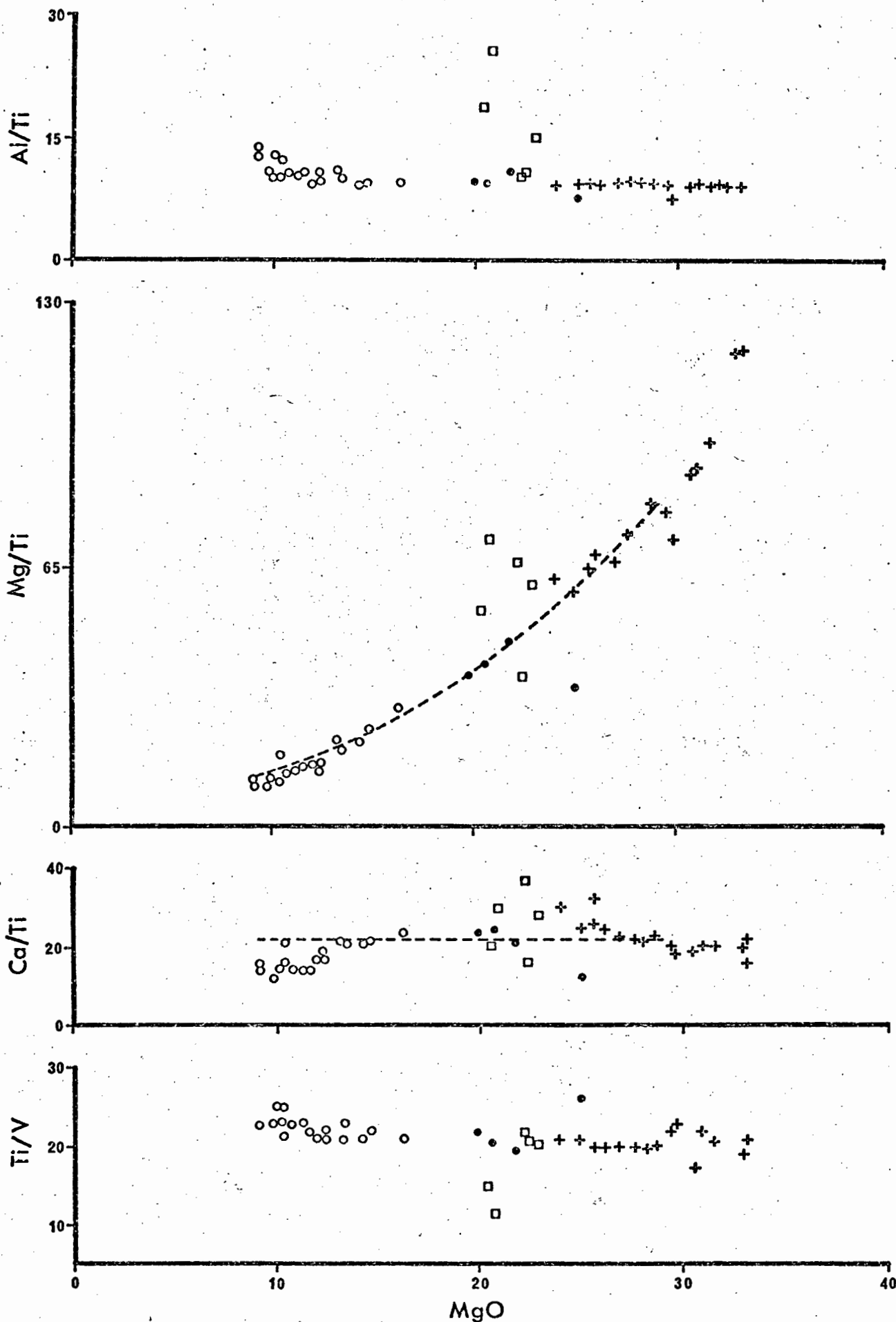


Fig. 6-8. Inter-element ratio variations with MgO content in the LUU komatiites. Ultramafic komatiites (group II) as crosses, aphyric high-Mg mafic komatiites as squares, porphyritic high-Mg mafic komatiites as dots and aphyric low-Mg mafic komatiites as circles.

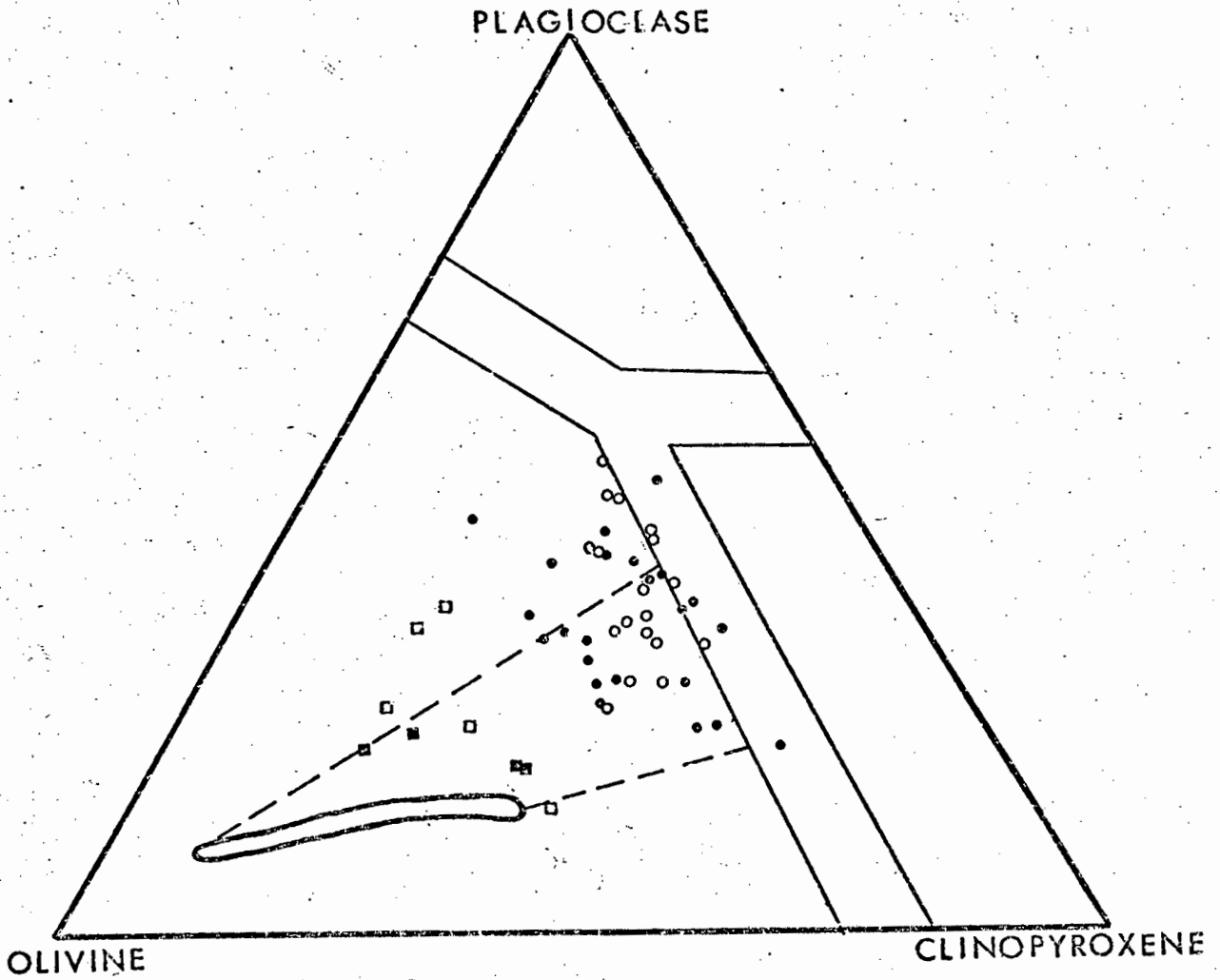


Fig. 6-9. Predicted 1 atmosphere phase relationships for komatiites. The aphyric ultramafic komatiites are represented by the outlined field, aphyric high-Mg mafic komatiites as squares, porphyritic high-Mg mafic komatiites as solid squares, aphyric low-Mg mafic komatiites as circles and porphyritic low-Mg mafic komatiites as dots. The phase boundaries are from Cox and Bell (1972).

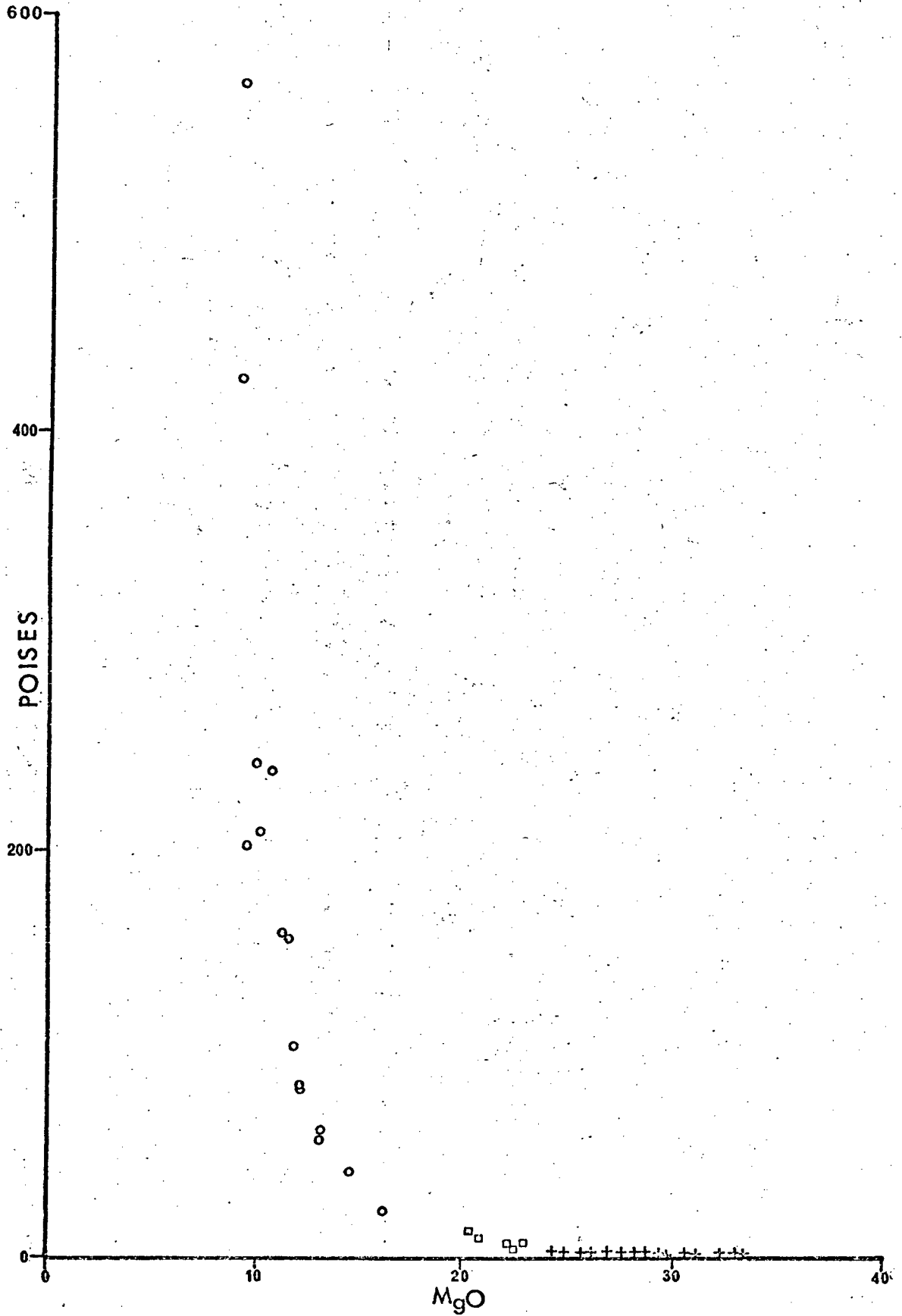


Fig. 6-10. Variations in calculated viscosities of komatiite magmas with MgO content. Ultramafic komatiites as crosses, high-Mg mafic komatiites as squares and low-Mg mafic komatiites as circles.

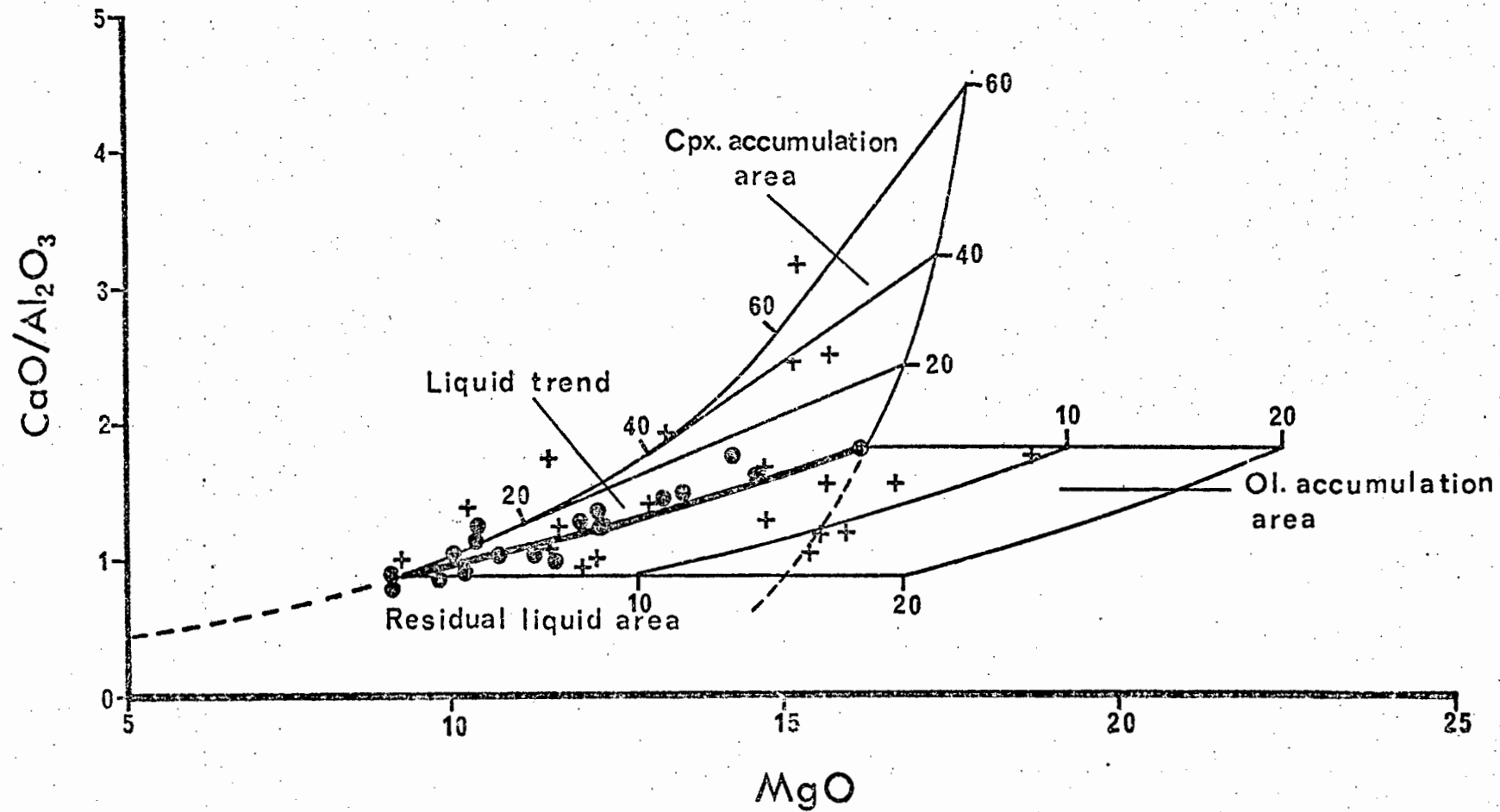


Fig. 6-11. Variations of the $\text{CaO}/\text{Al}_2\text{O}_3$ ratio with MgO (wt. %) content in the low-Mg mafic komatiites. The aphyric lavas are plotted as dots and the porphyritic samples are plotted as crosses. See text for detailed discussions of the clinopyroxene (cpx) and olivine (ol) accumulation trends.

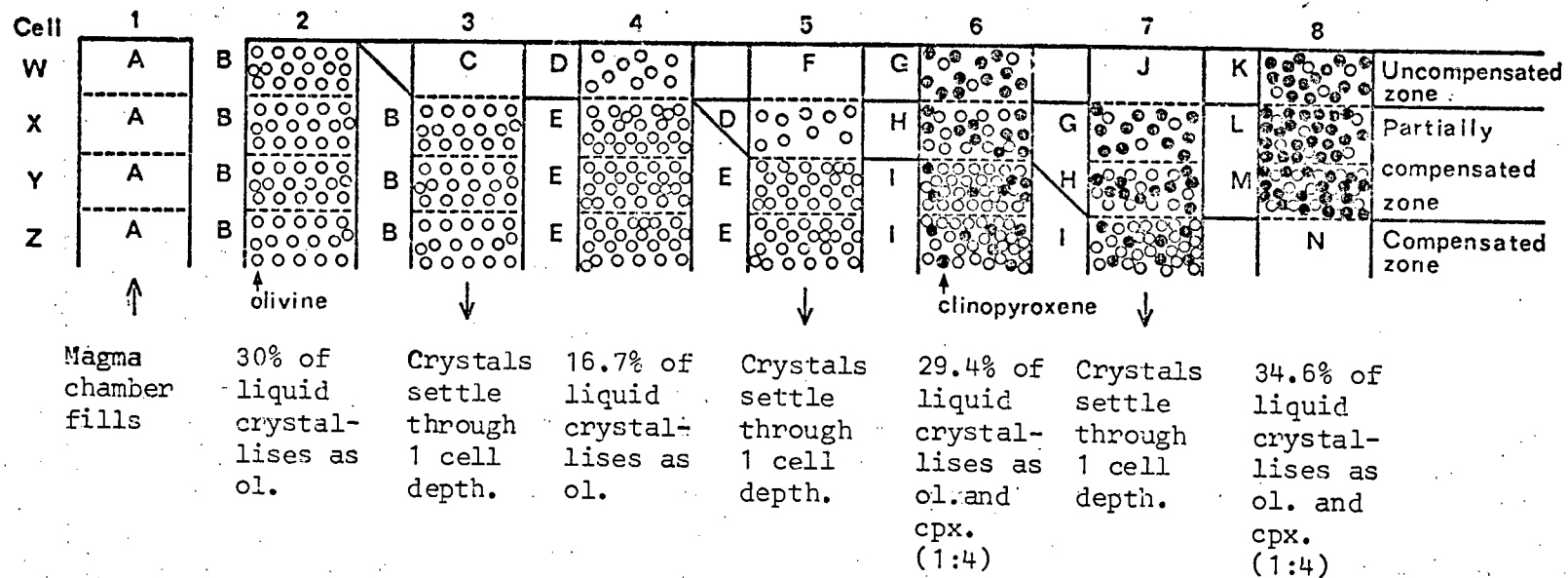


Fig. 6-12. Compensated, partially compensated and uncompensated crystal settling model.

A - 29% MgO (100% liquid), B - 29% MgO (30% ol., 70% liquid), C - 20% MgO (100% liquid), D - 20% MgO (16.7% ol., 83.3% liquid), E - 29% MgO (41.7% ol., 58.3% liquid), F - 14% MgO (100% liquid), G - 14% MgO (5.9% ol., 23.5% cpx., 70.6% liquid), H - 20% MgO (21.6% ol., 19.6% cpx., 58.8% liquid), I - 29% MgO (45.1% ol., 13.7% cpx., 41.2% liquid), J - 9% MgO (100% liquid), K - 9% MgO (6.9% ol., 27.7% cpx., 65.4% liquid), L - 14% MgO (10.8% ol., 43.0% cpx., 46.2% liquid), M - 20% MgO (25.7% ol., 35.9% cpx., 38.4% liquid), N - 29% MgO (48.0% ol., 25.1% cpx., 26.9% liquid).

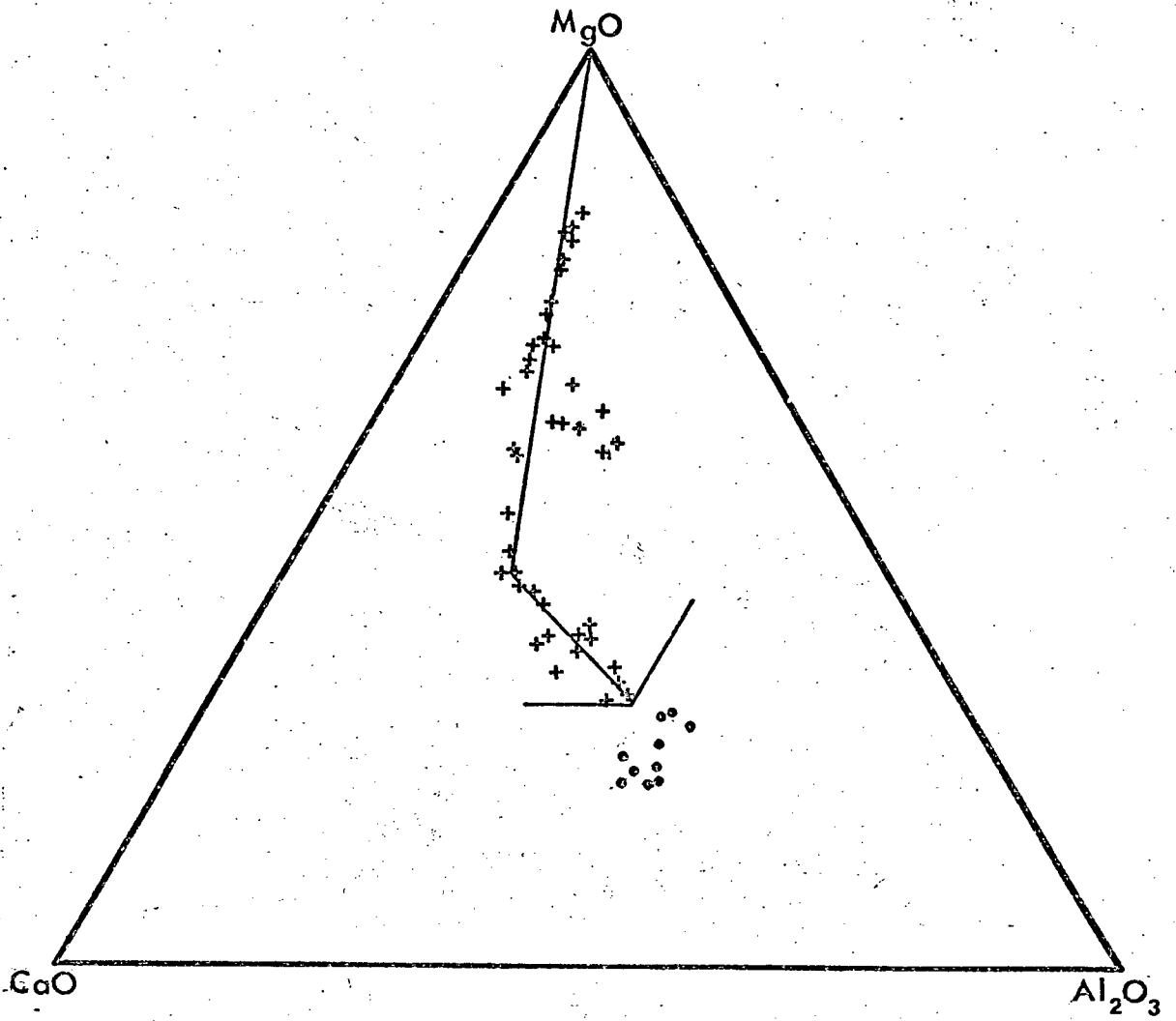


Fig. 6-13. MgO - CaO - Al₂O₃ relationships between komatiites (crosses) and tholeiites (dots) from the Barberton greenstone belt.

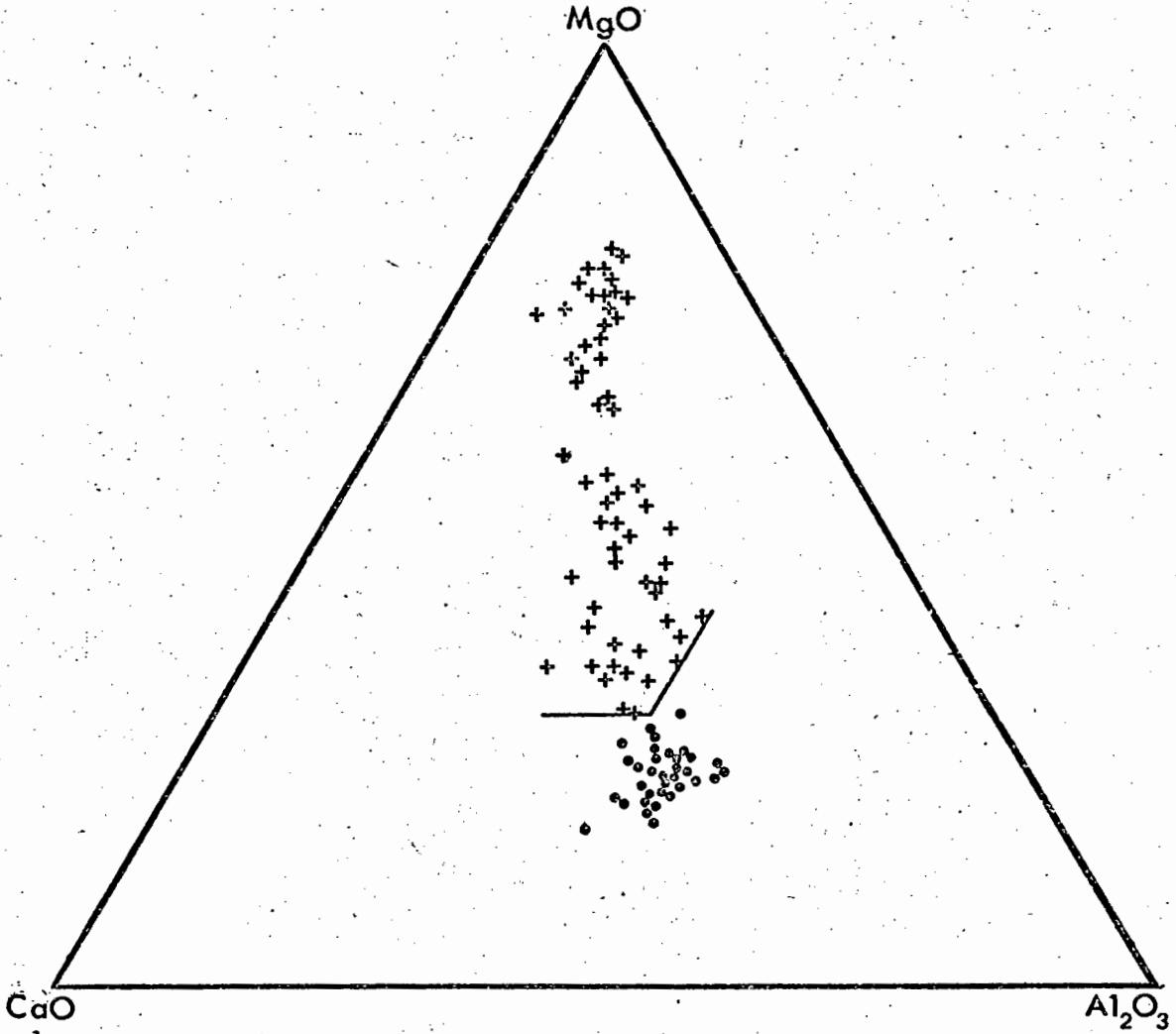


Fig. 6-15. MgO - CaO - Al₂O₃ relationships between komatiites (crosses) and tholeiites (dots) from the Western Australian greenstone belts. Sources of data are referenced in the text. The line separating the komatiites from the tholeiites is taken from Fig. 6-13.

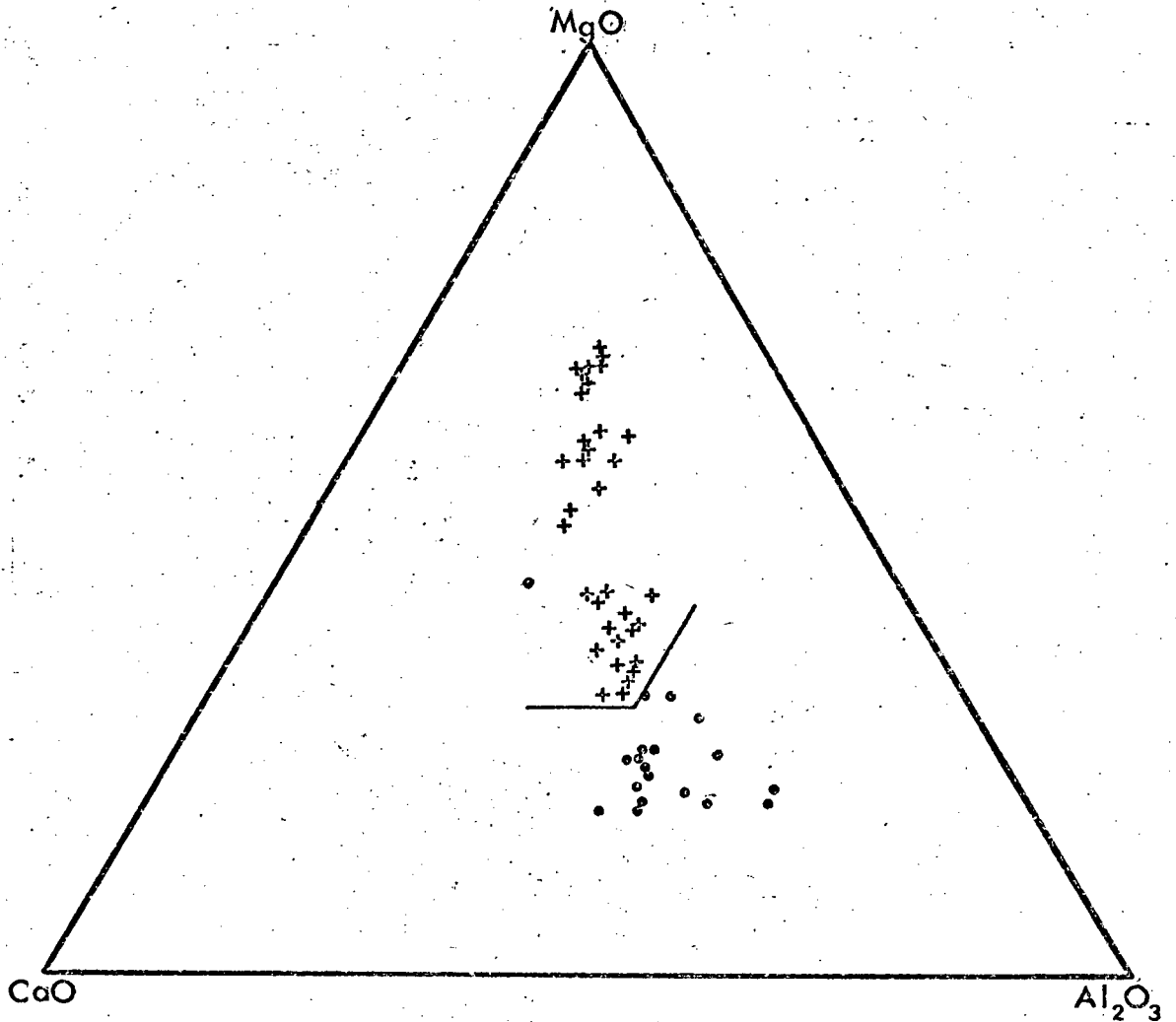


Fig. 6-16. MgO - CaO - Al₂O₃ relationships between komatiites (crosses) and tholeiites (dots) from the Munro Township area. Sources of data are referenced in the text. The line separating the komatiites from the tholeiites is taken from Fig. 6-13.

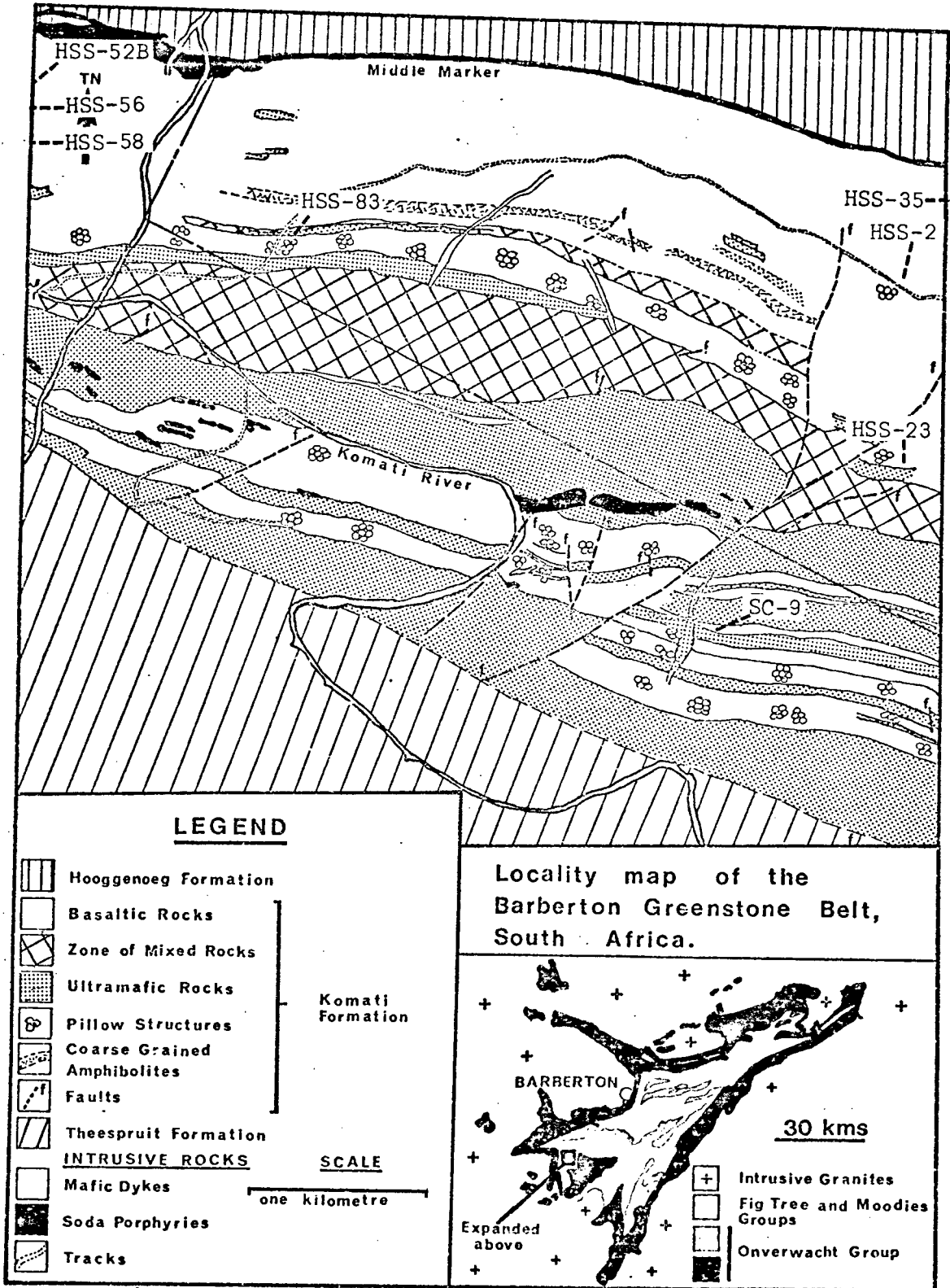


Fig. 7-1. A simplified geological map of the Komati Formation Type Area taken from Viljoen and Viljoen (1969c). The sample locations of the tholeiitic basalts are shown.

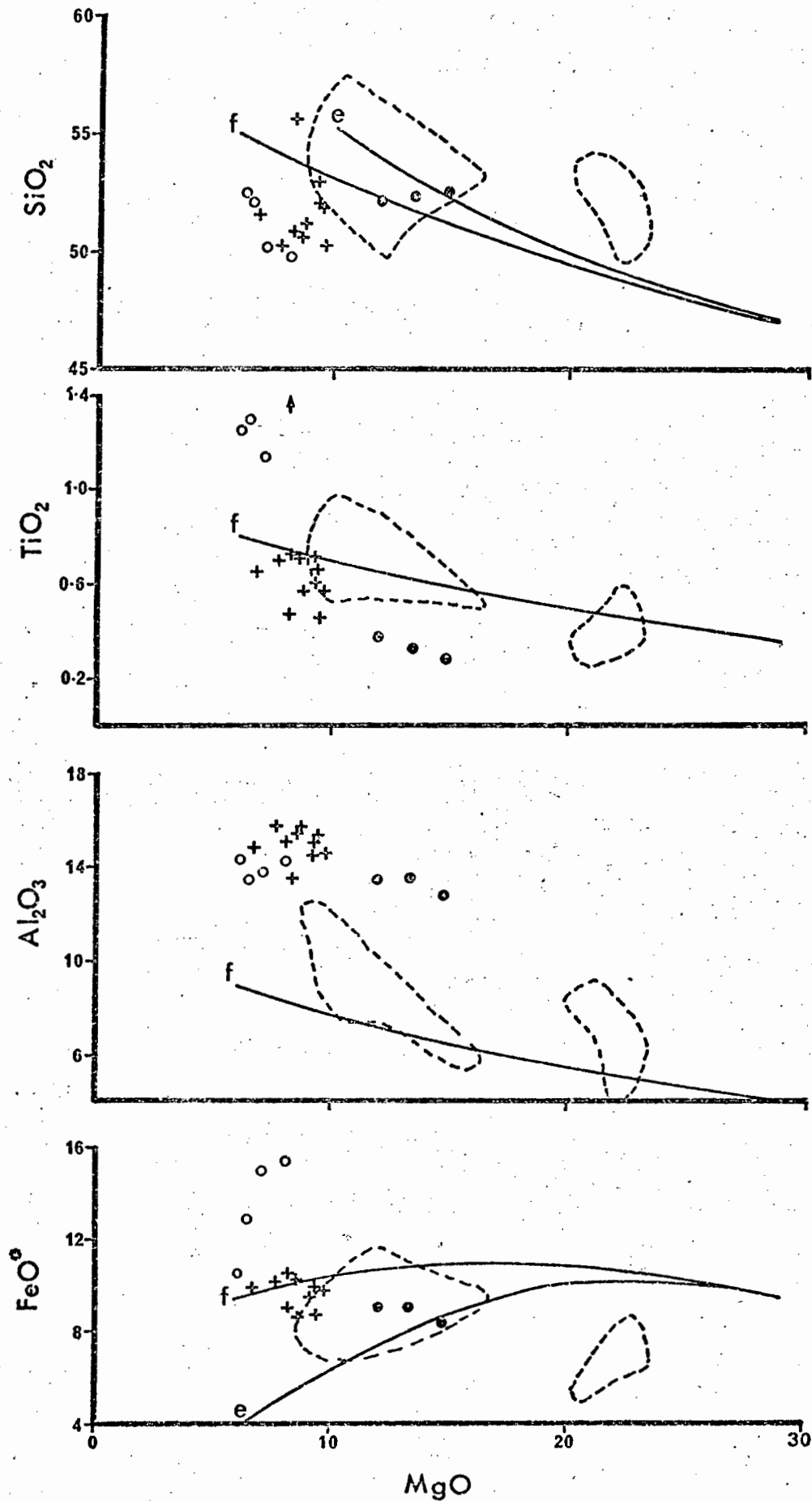


Fig. 7-2. Variations of selected oxides (wt.%) and elements (ppm) with MgO content in the basalts. FeO is total Fe as FeO. High-Mg basalts as dots, low-Ti basalts as crosses and high-Ti

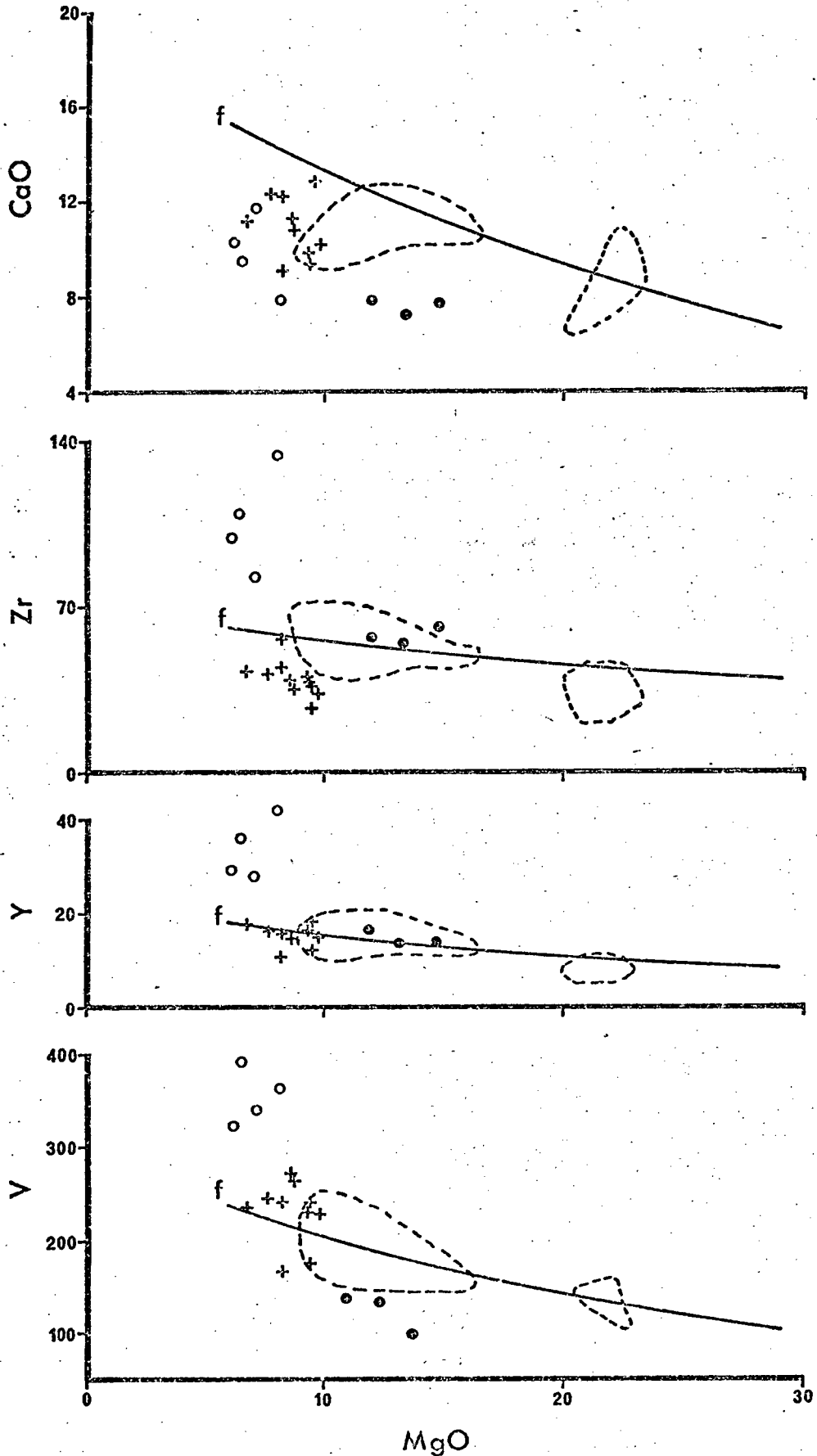


Fig. 7-2 (Continued) basalts as circles. The fields occupied by the aphyric high-Mg and low-mg mafic komatiites are outlined. f and e are the fractional and equilibrium olivine crystallisation trends for group II ultramafic komatiites.

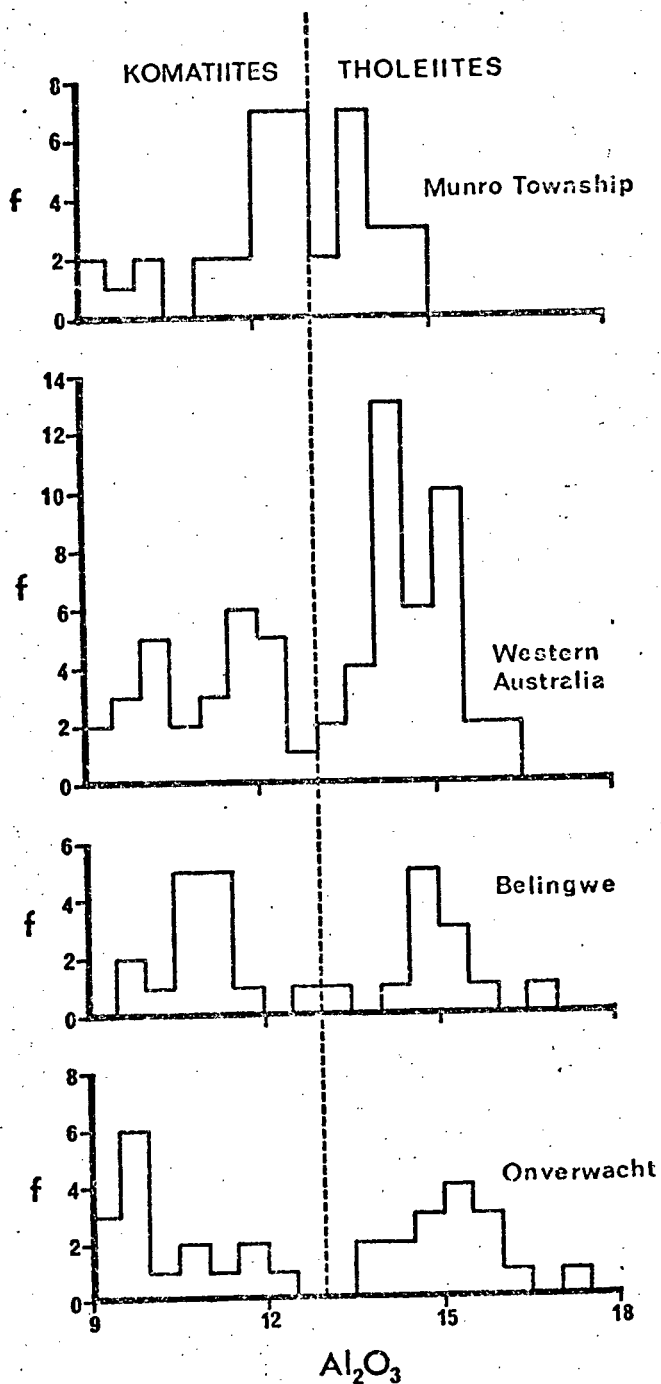


Fig. 7-3. Histograms of the Al_2O_3 content of lavas from greenstone belts. The dashed line is drawn in at 13% Al_2O_3 and separates komatiites from tholeiites in the Onverwacht Group.

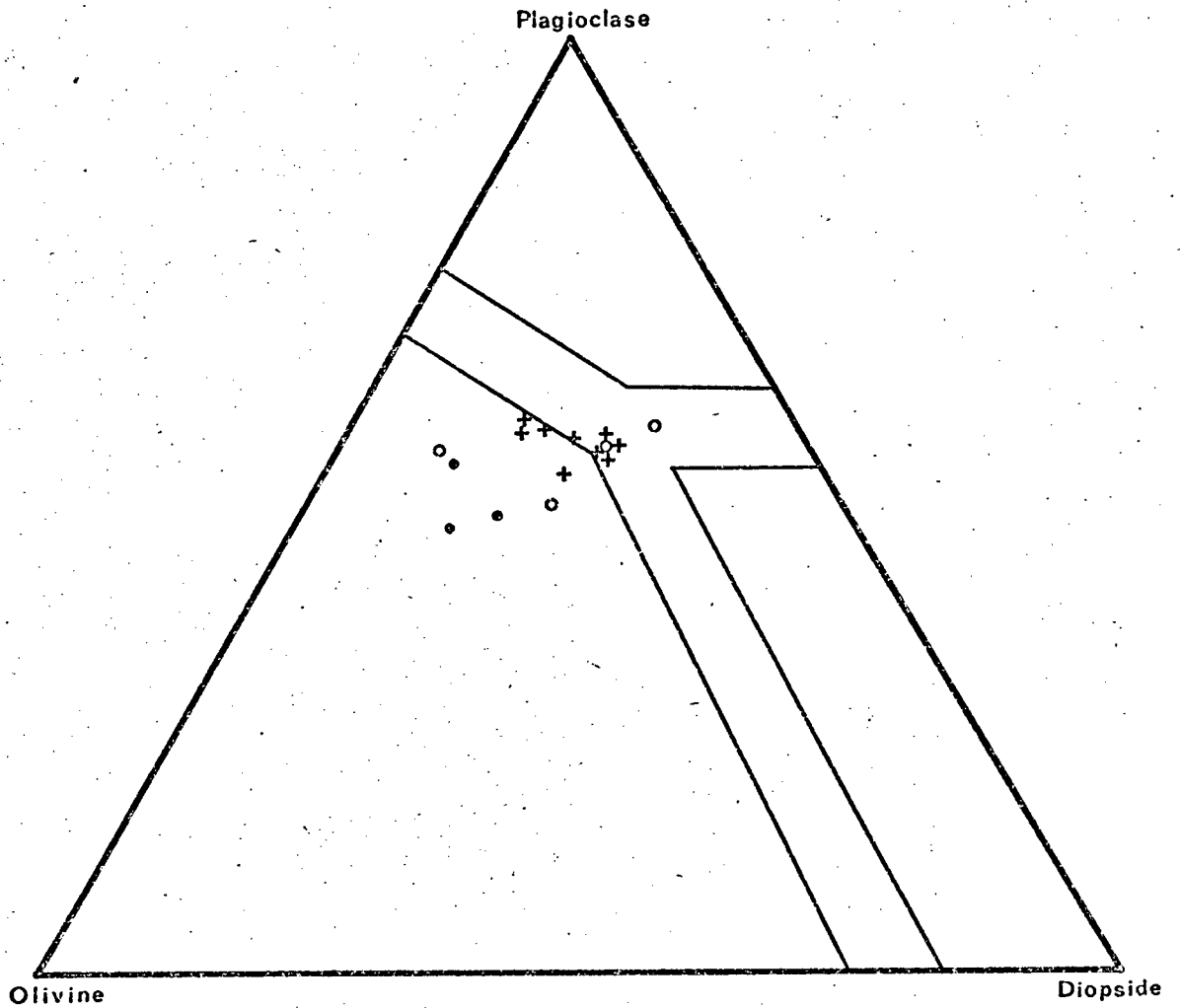


Fig. 7-4. Predicted one atmosphere phase relationships in the basalts from the Onverwacht Group. High-Mg basalts as dots, low-Ti basalts as crosses and high-Ti basalts as circles. The phase boundaries are from Cox and Bell (1972).

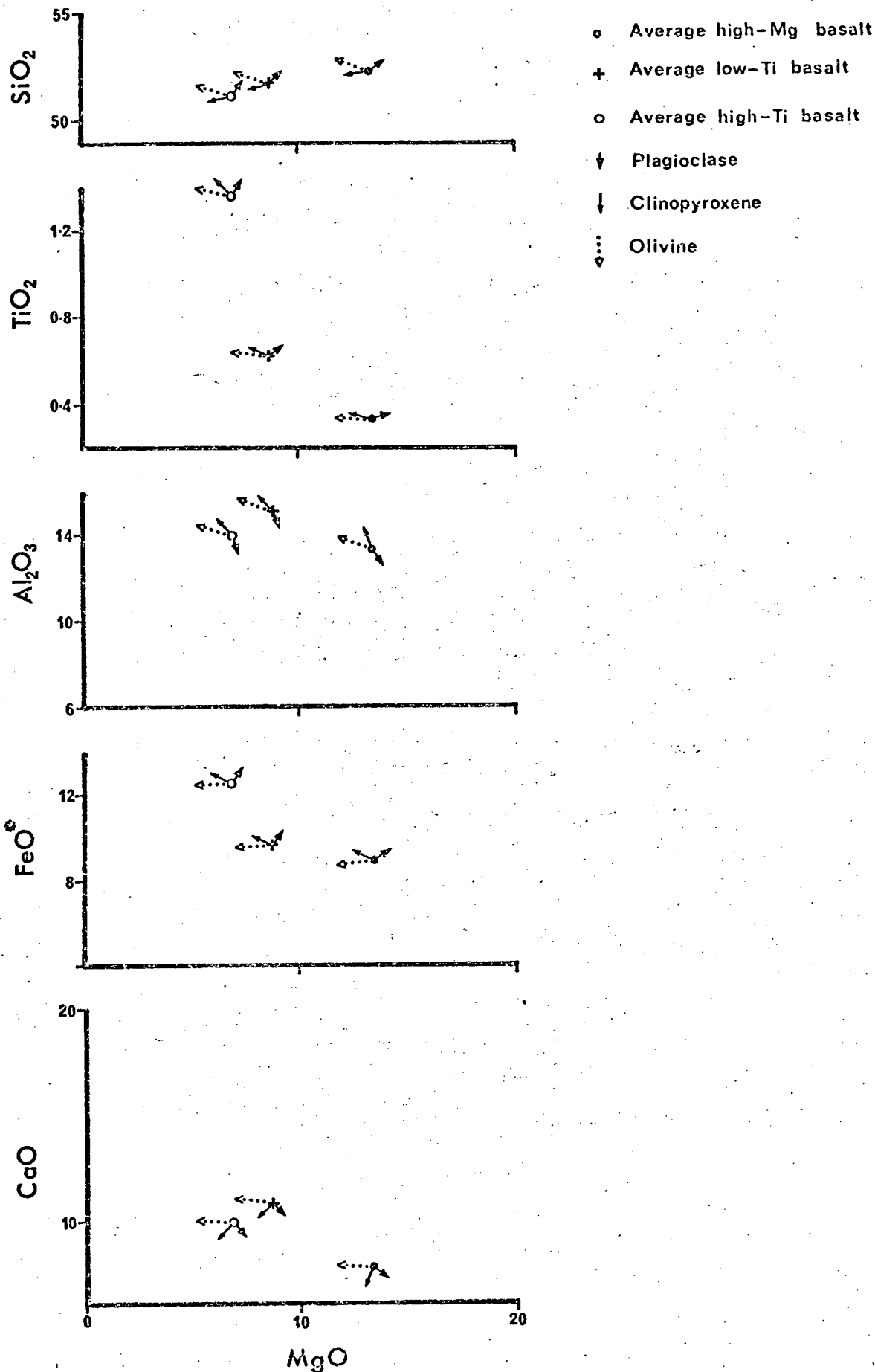


Fig. 7-5. Vectors of residual liquid trends resulting from the crystallisation of mineral phases from the average compositions of the basalt types. Fe^o is total Fe expressed as FeO.

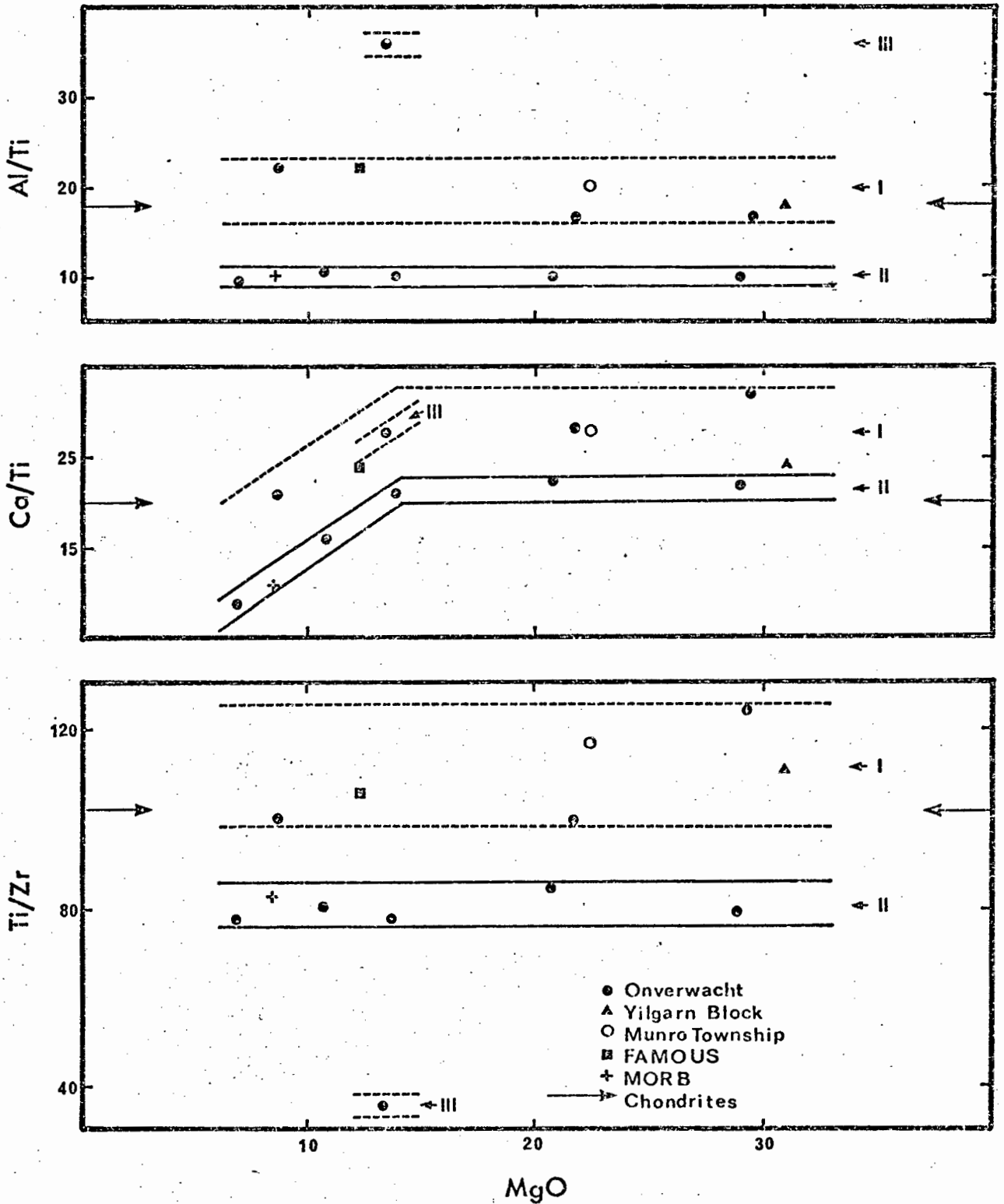


Fig. 7-6. Selected average inter-element ratios for various types of lavas in the three groups of rocks from the Onverwacht Group. Average inter-element ratios of komatiite and tholeiite from other areas are shown as well as the chondrite values.

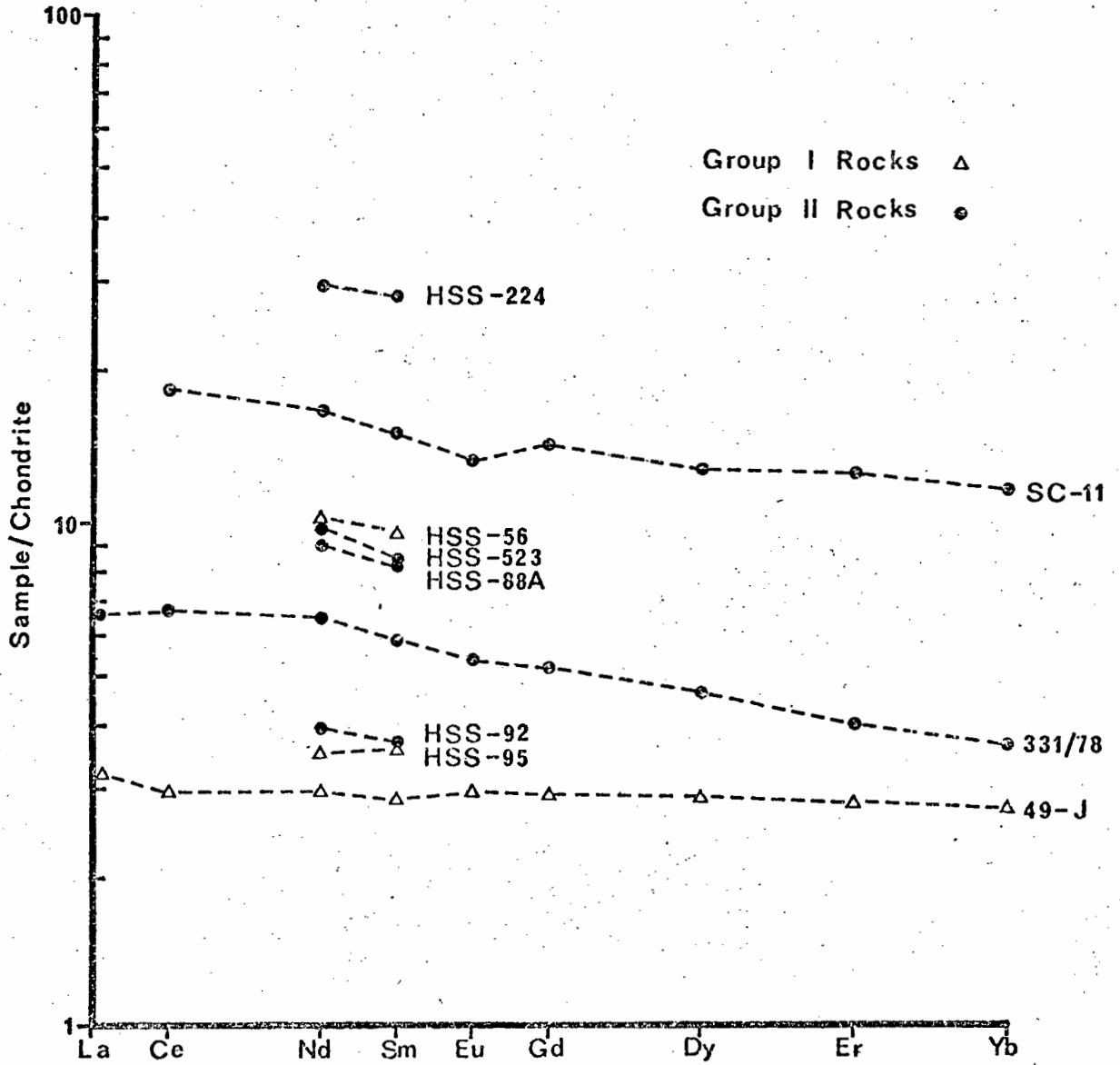


Fig. 7-7. Chondrite normalized REE patterns for selected lavas from the Onverwacht Group. Sources of data are referenced in the text.

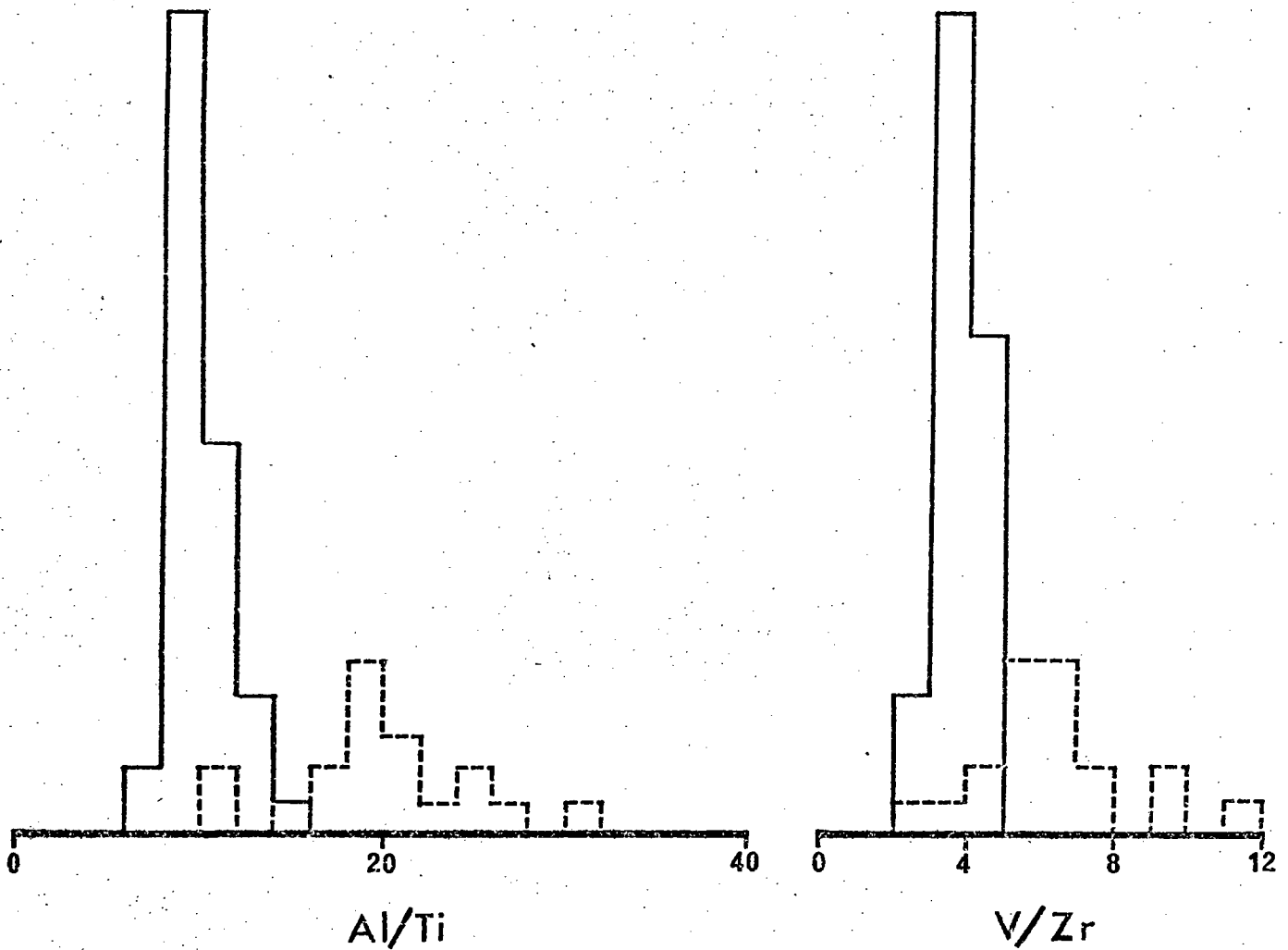
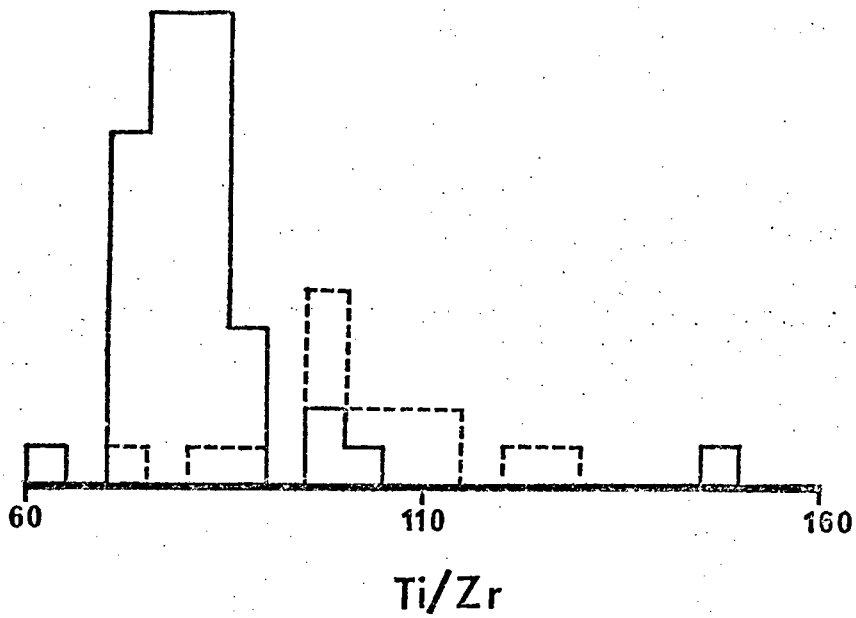


Fig. 7-8. Histograms of selected inter-element ratios in group I (dashed line) and group II (solid line) aphyric lavas from the Onverwacht Group.

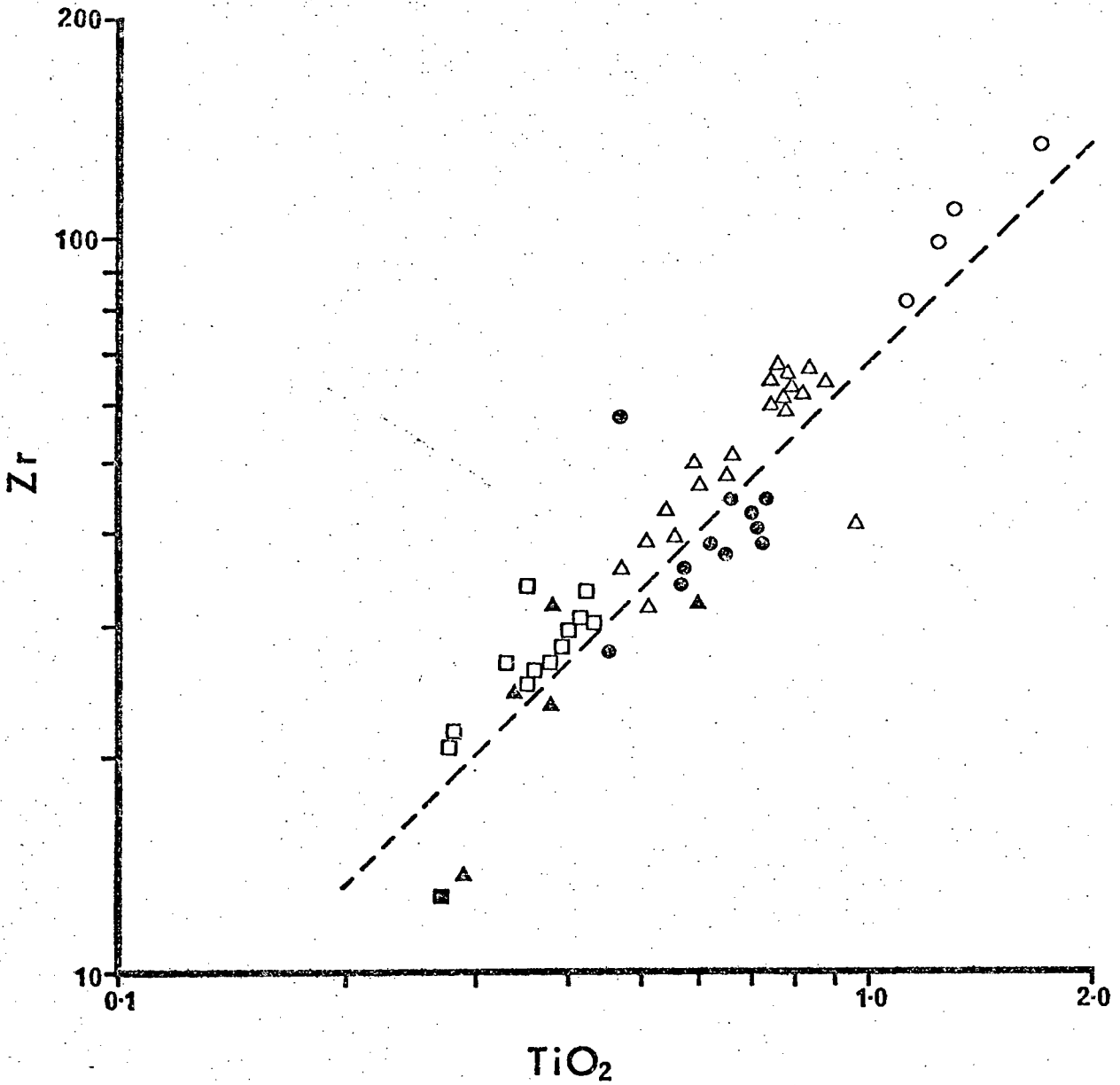


Fig. 7-9. Comparison of TiO₂ (wt. %) and Zr (ppm) contents in group I and II komatiites and tholeiites from the Onverwacht Group. Filled symbols are group I lavas and open symbols are group II lavas. Tholeiites are plotted as circles, mafic komatiites as triangles and ultramafic komatiites as squares.

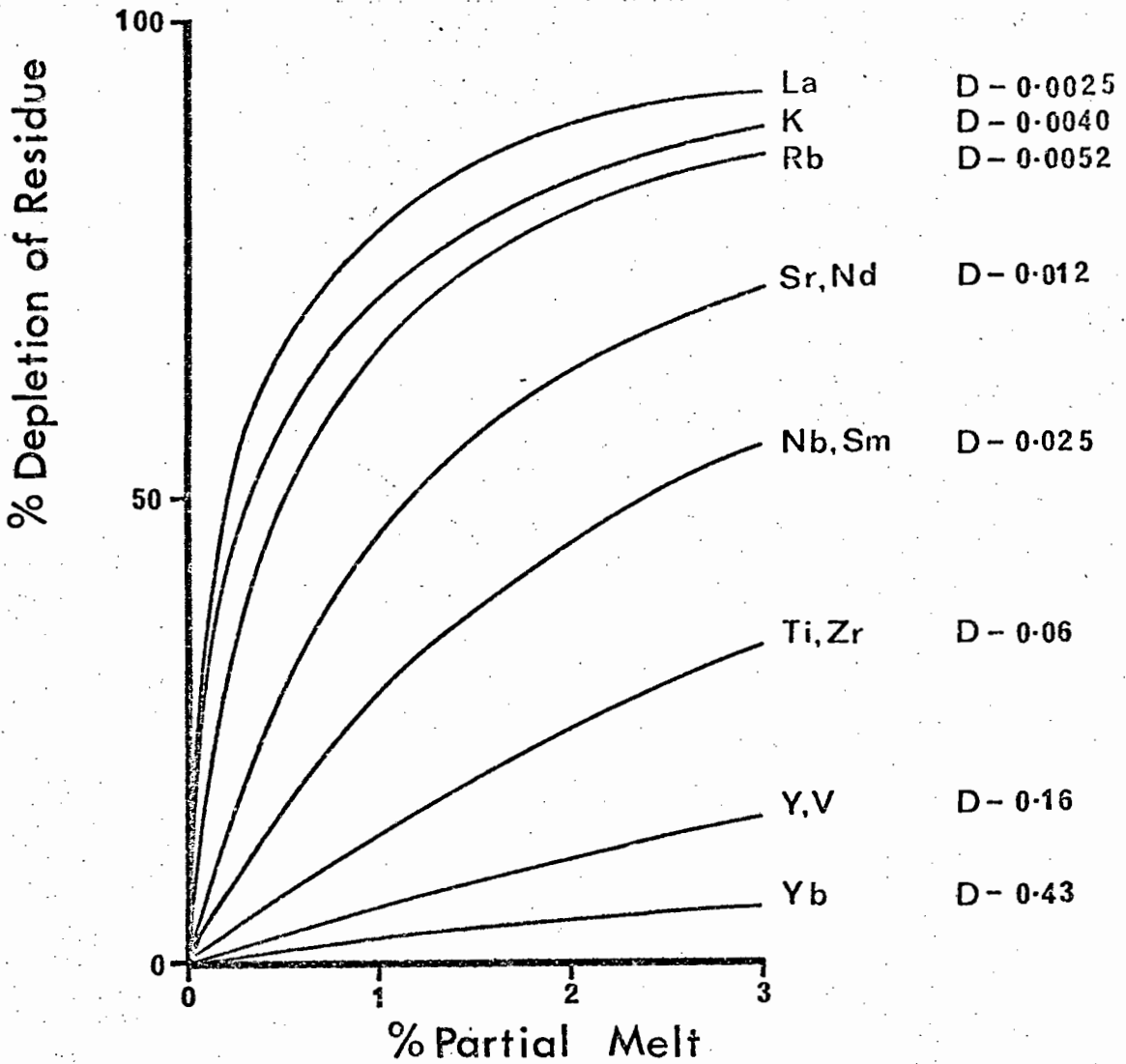


Fig. 7-10. The effects of removing small amounts of melt on element concentrations in the residue. Bulk distribution coefficients for the elements are given. See text for discussion of the modelled initial and residual mantle mineralogy and sources of the distribution coefficient data.

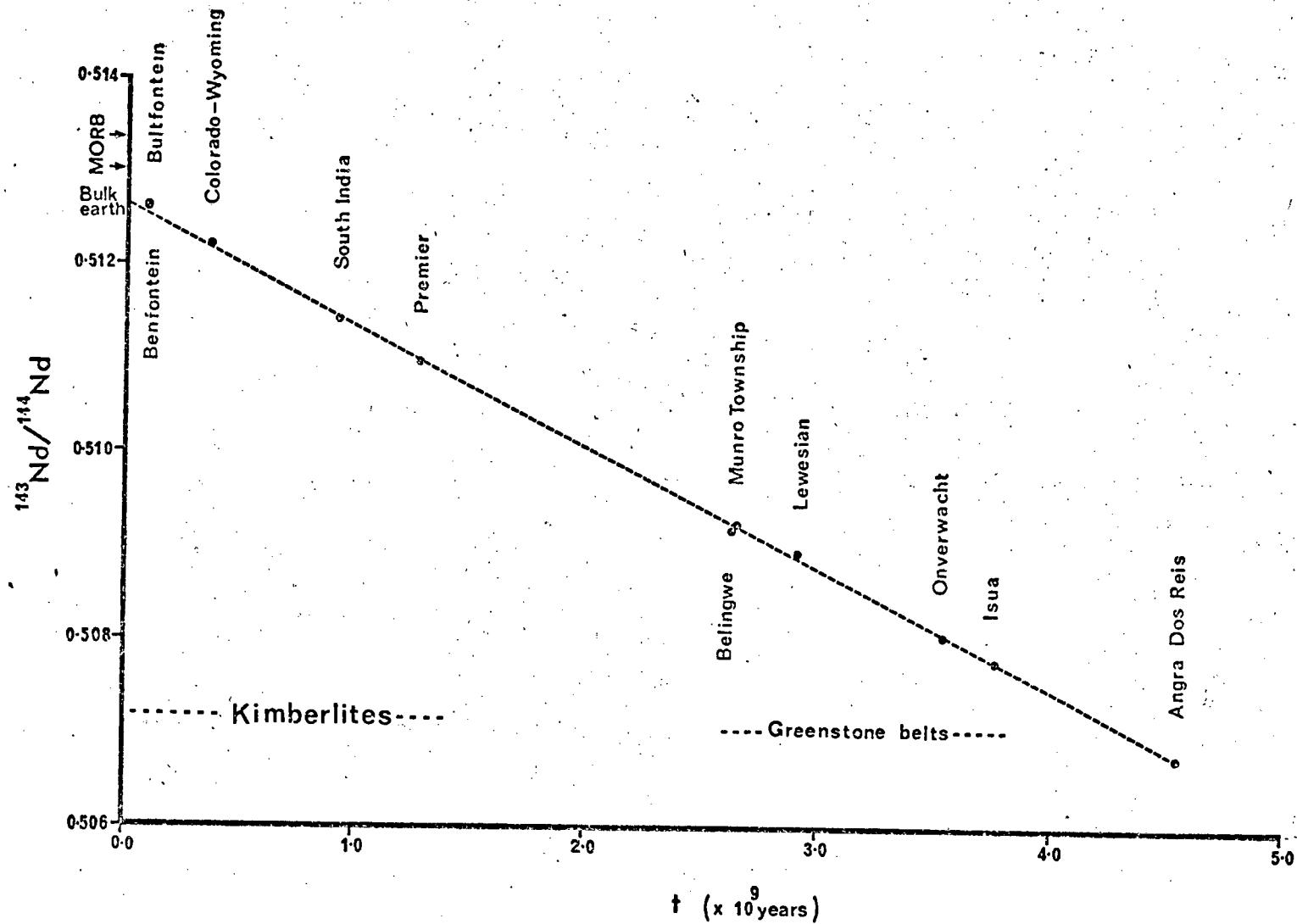


Fig. 7-11. Initial $^{143}\text{Nd}/^{144}\text{Nd}$ isotopic composition for greenstone belt lavas and kimberlites of various ages. The present day bulk earth composition was calculated assuming the initial isotopic composition of Angra Dos Reis 4550 million years ago and a chondritic Sm/Nd ratio (O'Nions et al., 1979).

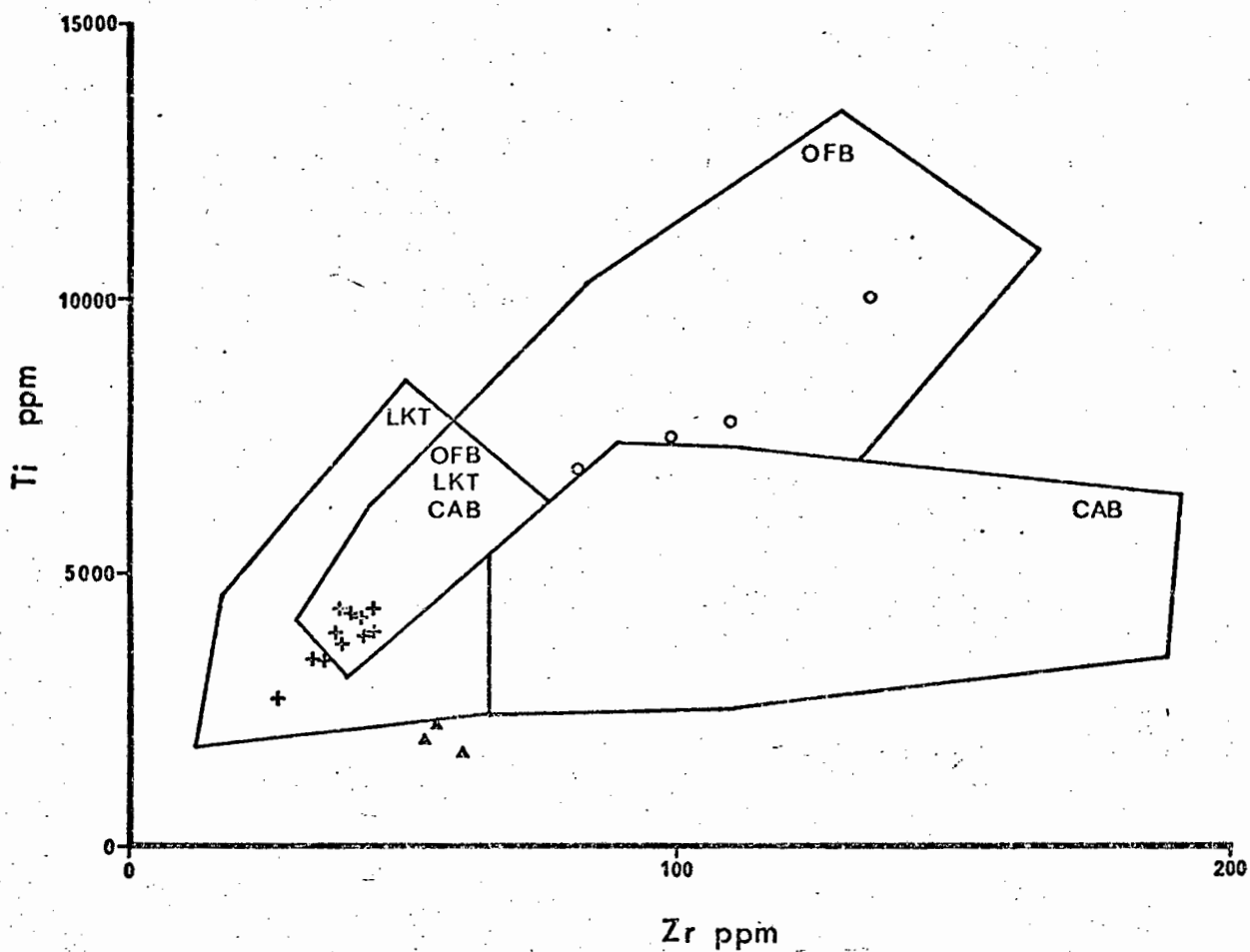


Fig. 7-12. Tectonic settings of the Onverwacht Group basalts inferred from Ti-Zr relationships (Pearce and Cann, 1973). High-Mg basalts plotted as triangles, low-Ti basalts as crosses and high-Ti basalts as circles. OFB - ocean floor basalts, LKT-low-K tholeiites, CAB-calc-alkali basalts.

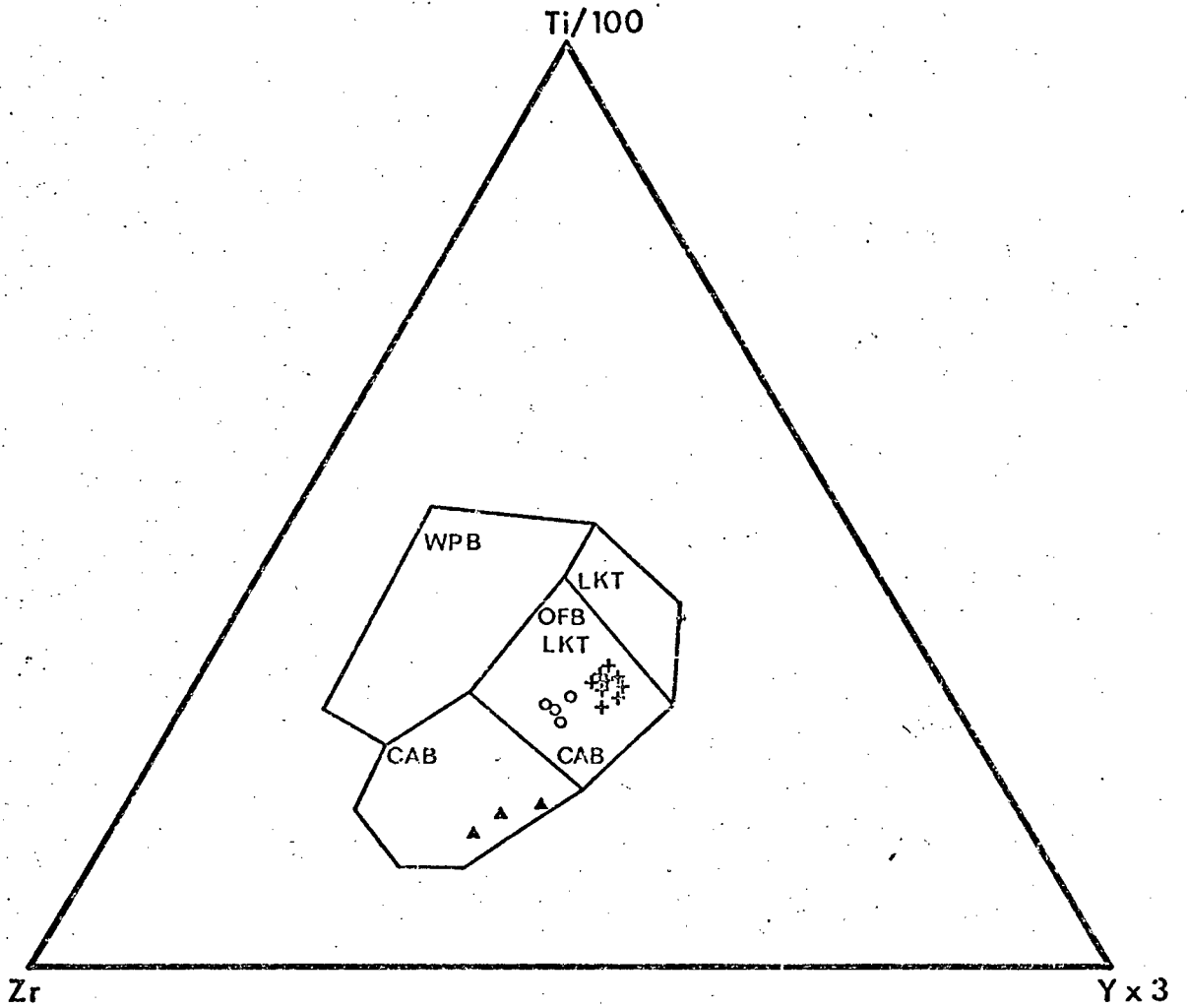


Fig. 7-13. Ti-Zr-Y relationships of the Onverwacht Group basalts compared to similar relationships found in lavas from different tectonic settings (Pearce and Cann, 1973). Ornamentation as for Fig. 7-12. WPB - within plate basalts.

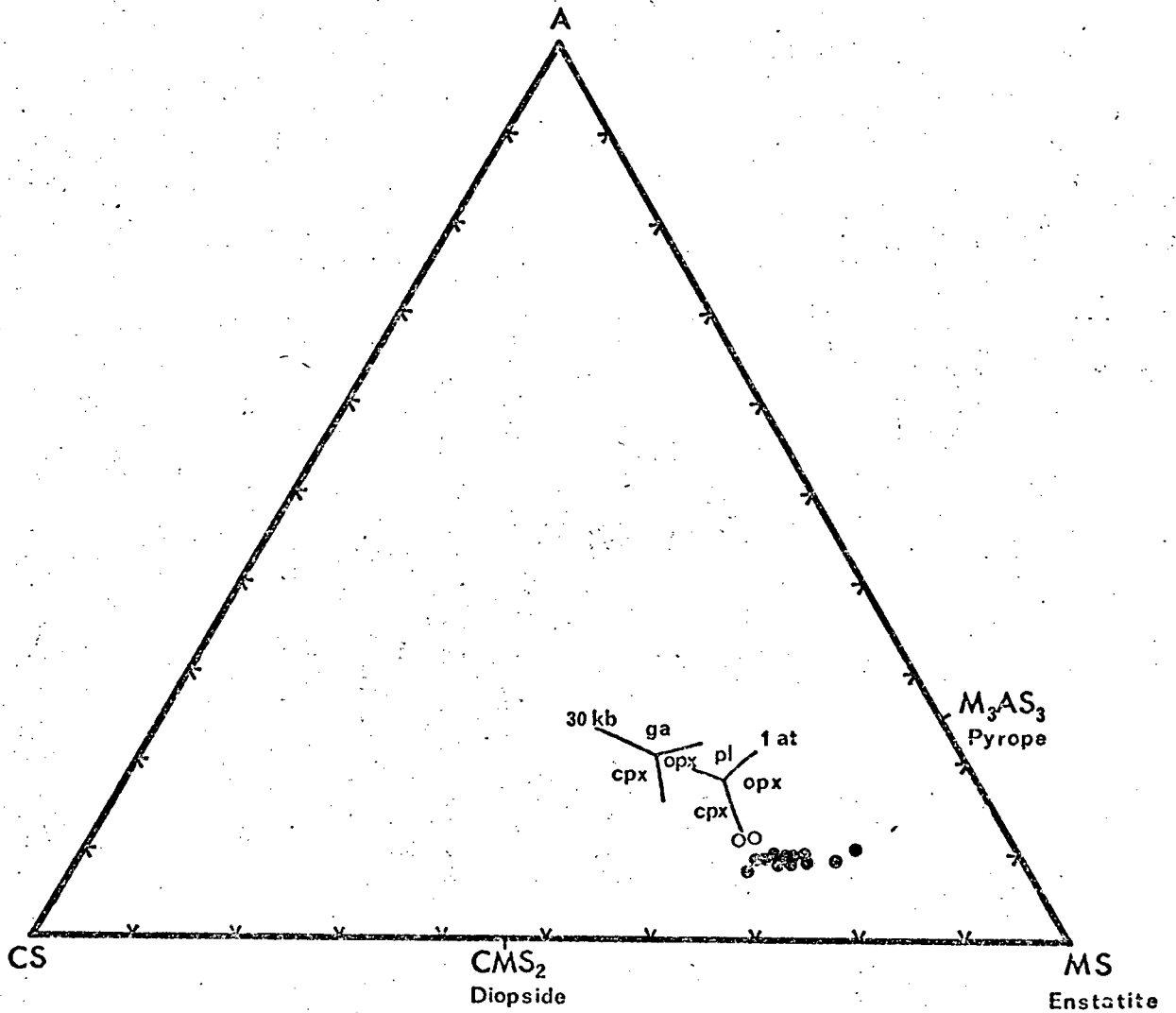


Fig. 8-1. Projection from or towards olivine (M_2S) onto the plane CS-MS (enstatite)-A. The phase boundaries are from O'Hara (1968). The projected compositions of the LUU aphyric ultramafic komatiites are shown as circles (group I) and dots (group II). opx-orthopyroxene, cpx-clinopyroxene, pl-plagioclase and ga-garnet.

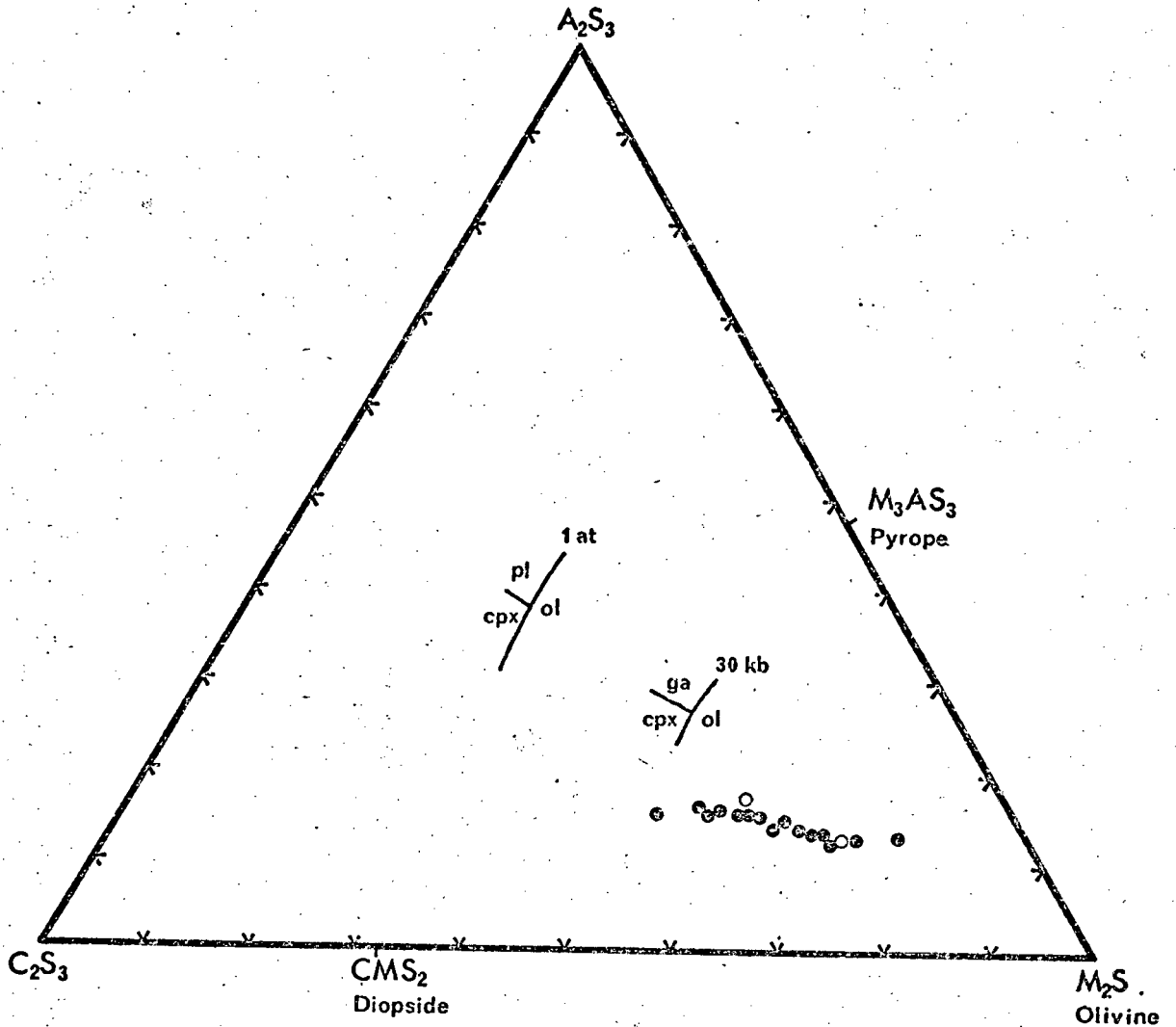


Fig. 8-2. Projection from orthopyroxene (MS) onto the plane M_2S (olivine)- C_2S_3 - A_2S_3 . Phase boundaries are from O'Hara (1968). Ornamentation and lettering as in Fig. 8-1.

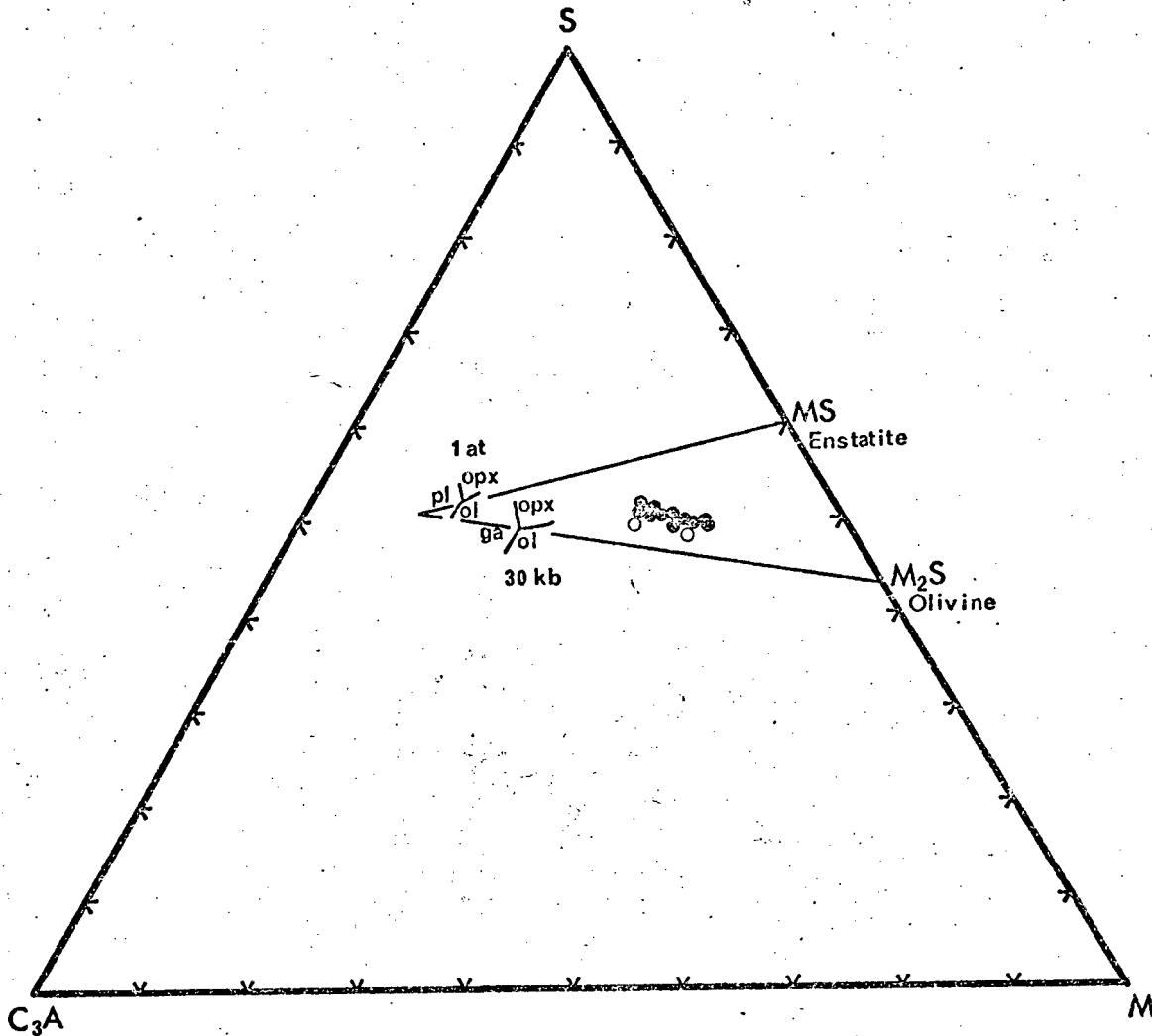


Fig.8-3. Projection from diopside (CMS_2) onto the plane C_3A -M-S. The phase boundaries are from O'Hara (1968). The line from enstatite is the hypersthene-gabbro divide and the line from olivine is the olivine-gabbro thermal divide. Ornamentation and lettering as in Fig. 8-1.

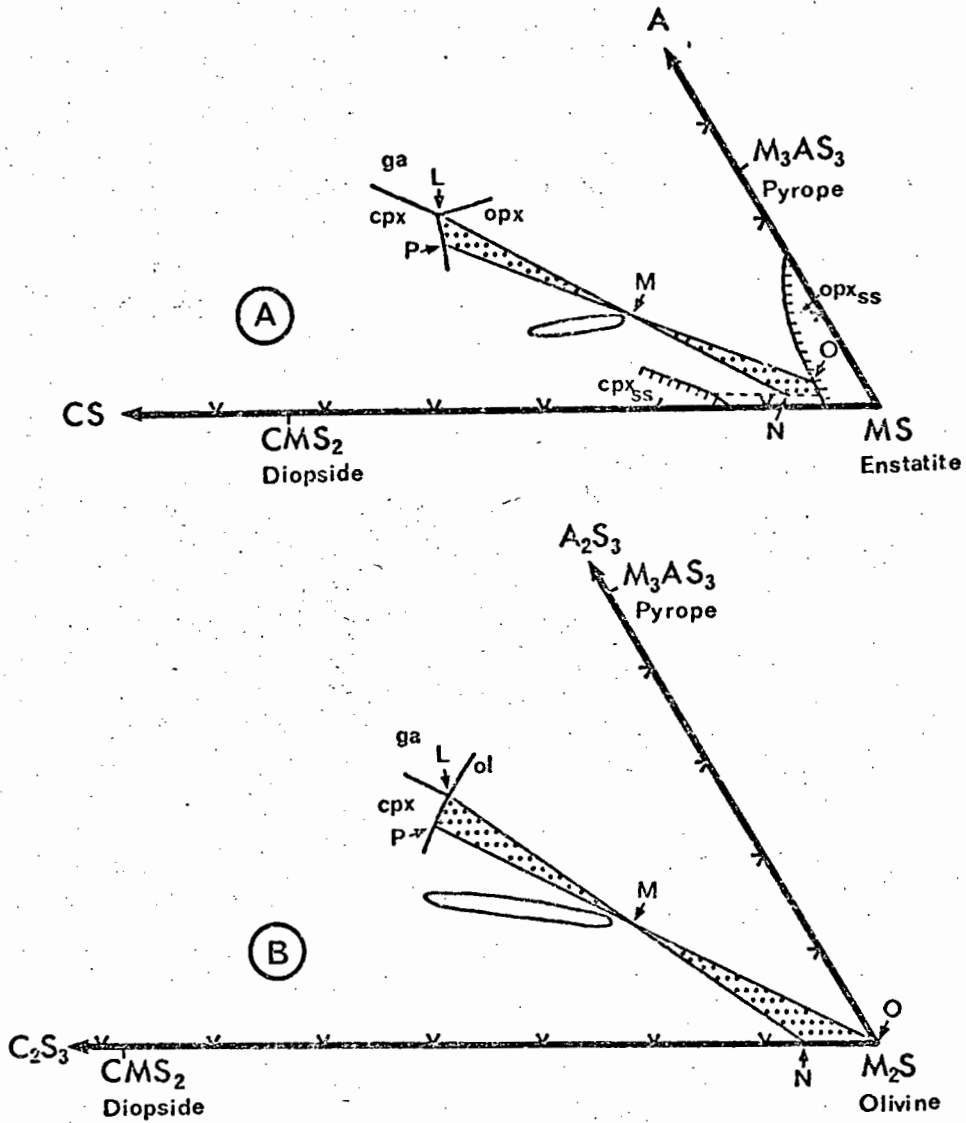


Fig. 8-4 A), Projection from or towards olivine (M_2S) onto the plane CS-MS (enstatite)-A. The pyroxene solid solution compositions at points N and O have been chosen for illustrative purposes only. The boundaries of opx and cpx solid solution (ss) and the phase boundaries pertain to 30 kb pressure (O'Hara, 1968).

B) Projection from orthopyroxene onto the plane M_2S (olivine)- C_2S_3 - A_2S_3 . Phase boundaries (30 kb) are from O'Hara (1968).

The outlined field represents the compositions of the group II aphyric ultramafic komatiites from the LUU. See text for additional explanation of the diagram.

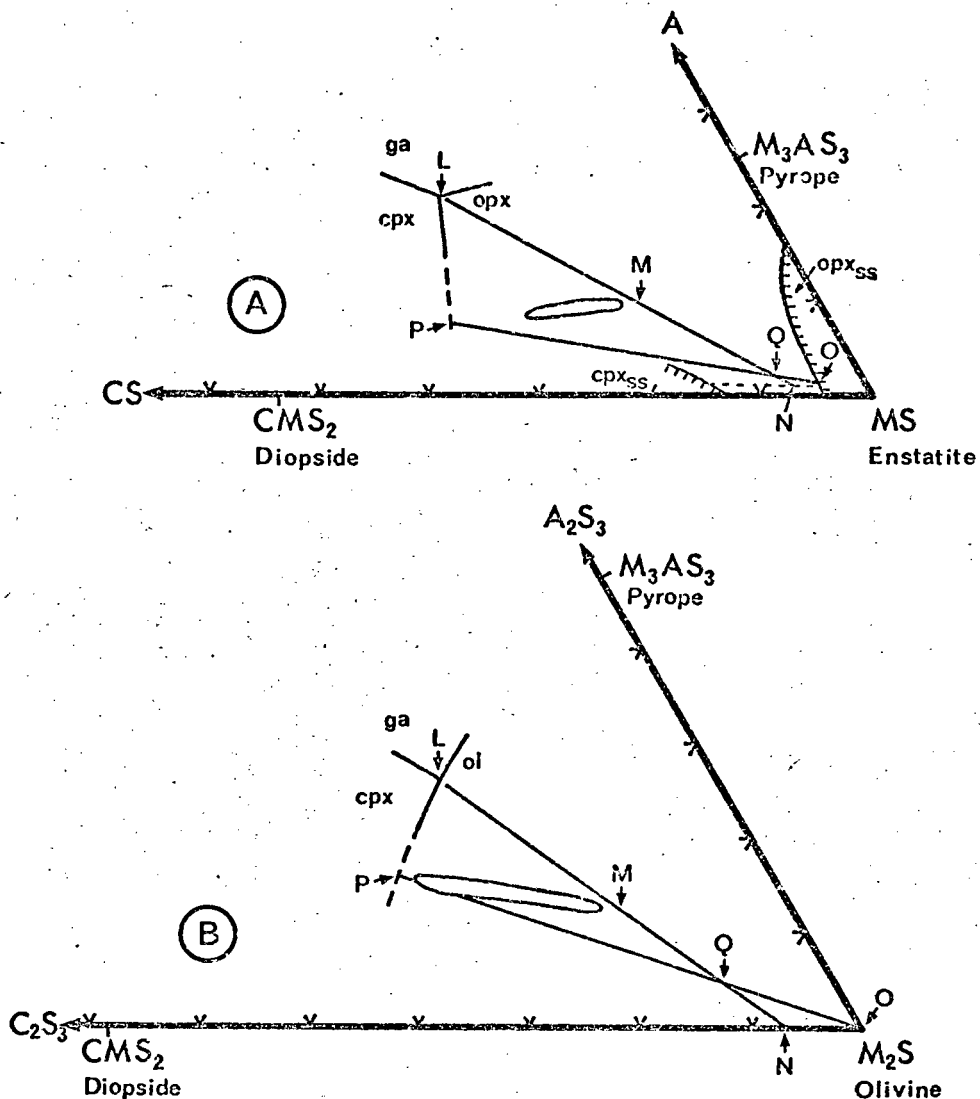


Fig. 8-5 A) Projection from or towards olivine (M_2S) onto the plane CS-MS (enstatite)-A. The 30 kb cpx-opx boundary has been extrapolated (dashed curve) further than the phase boundary given in O'Hara (1968). The pyroxene solid solution boundaries are from O'Hara (1968) and points N and O have been chosen to illustrate solid solution in the residual pyroxene.

B) Projection from enstatite (MS) onto the plane M_2S (olivine)- C_2S_3 - A_2S_3 . The 30 kb cpx-ol phase boundary from O'Hara (1968) has been extrapolated as shown (dashed curve).

The outlined field represents the compositions of the group II aphyric ultramafic komatiites from the LUU. See text for additional explanation of the diagram.

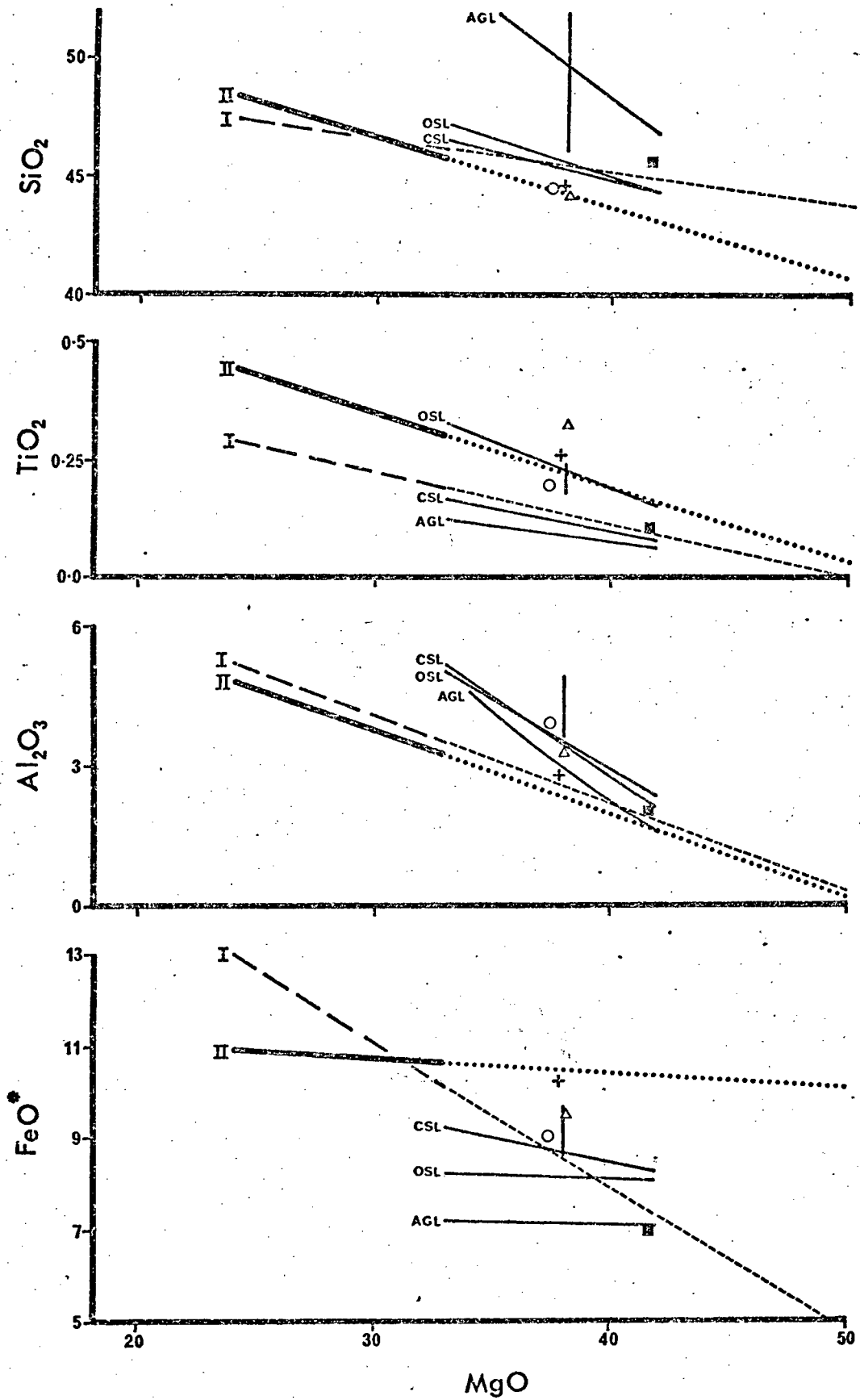


Fig. 8-6. The trends of the group I (dashed lines) and group II (heavy and dotted lines) aphyric ultramafic lavas from the LUU have been extrapolated to higher MgO contents. FeO is total Fe expressed as FeO.

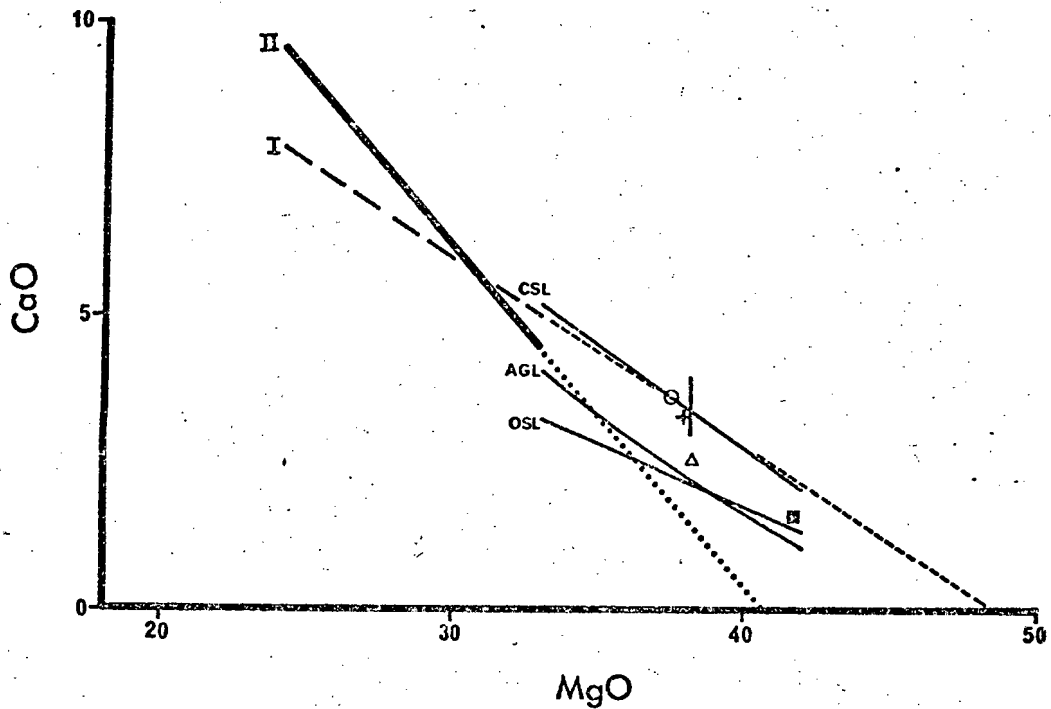


Fig. 8-6 (Continued) The trends labelled CSL, OSL and AGL are the trends given in Maaloe and Aoki (1977) for continental spinel lherzolites, oceanic spinel lherzolites and African garnet lherzolites respectively. The cross is PHN-1611 (Nixon and Boyd, 1973), the triangle is the average fertile Premier garnet lherzolite (Danchin, 1979), the circle is Archaean pyroxenite (Green, 1975) and the vertical bar represents the range of Archaean mantle compositions suggested by Sun and Nesbitt (1977).

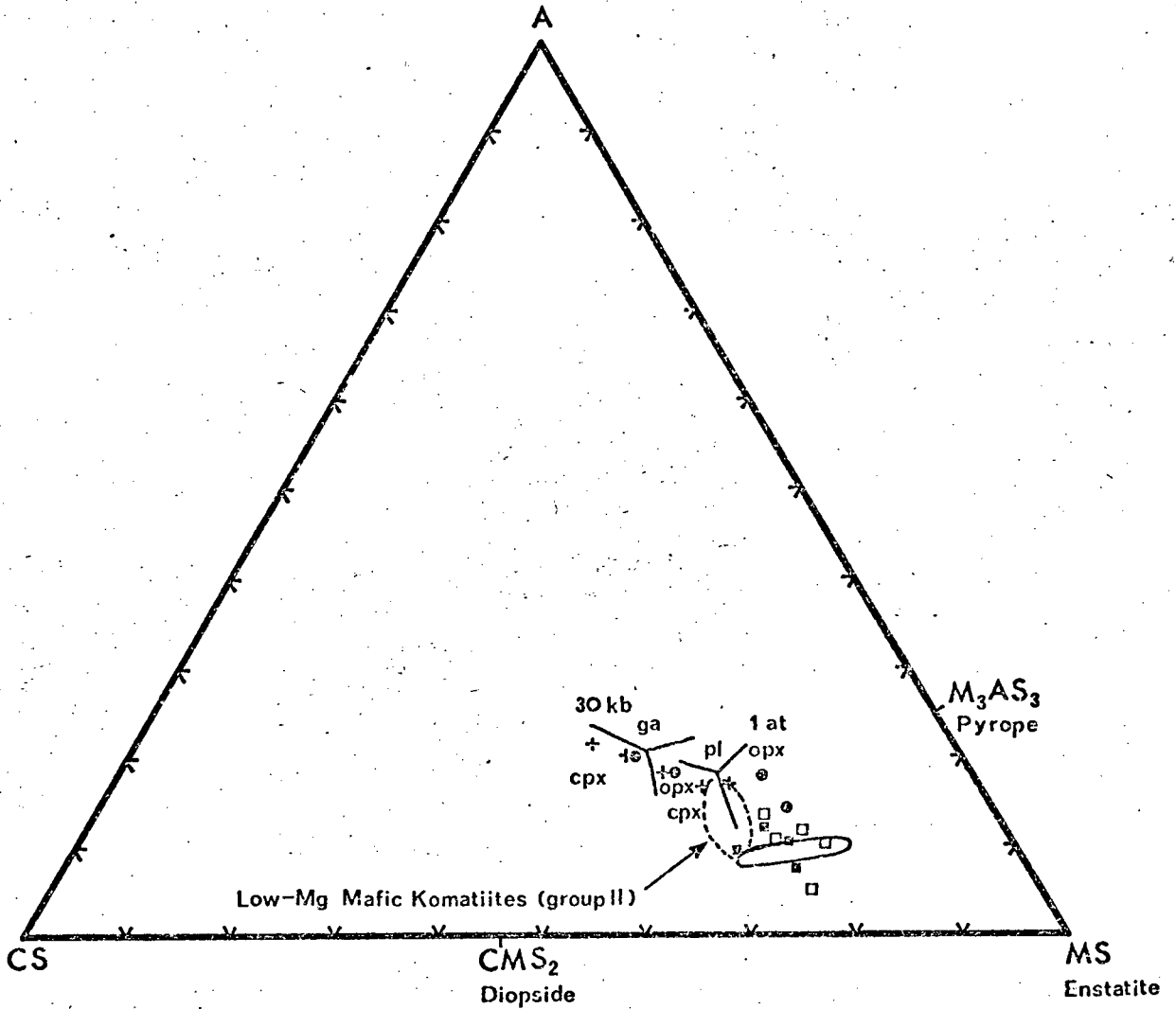


Fig. 8-7. Projection from or towards olivine (M_2S) onto the plane CS-MS (enstatite)-A. The phase boundaries are from O'Hara (1968). The group II ultramafic field is outlined. The aphyric high-Mg mafic komatiites as open squares, the porphyritic high-Mg mafic komatiites as solid squares and the field occupied by the low-Mg mafic komatiites is outlined (dashed line). A representative range of low-Ti tholeiites is plotted as dots and the high-Ti tholeiites are plotted as crosses. Abbreviations are opx-orthopyroxene, ol-olivine, cpx-clinopyroxene, pl-plagioclase and ga-garnet.

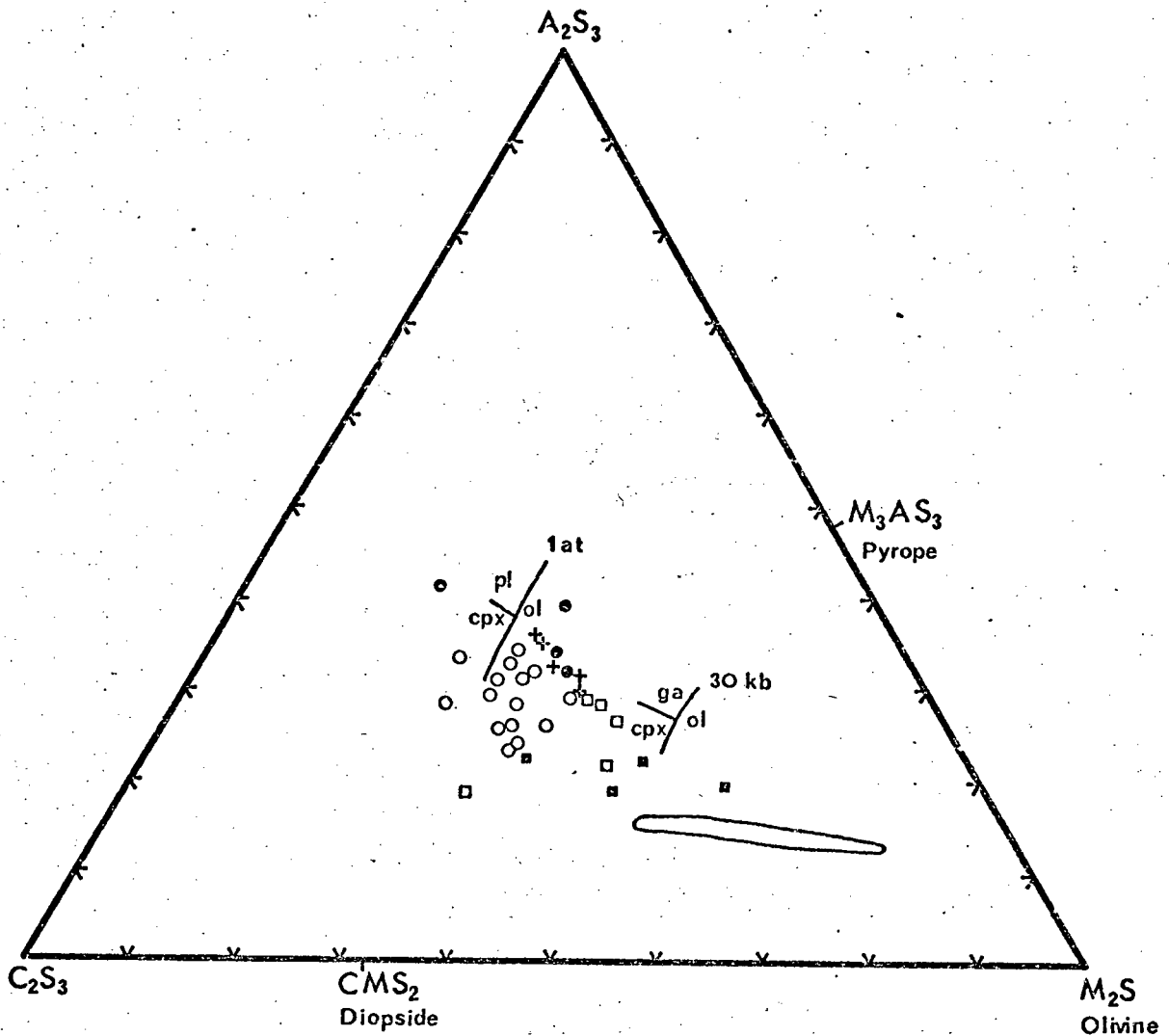


Fig. 8-8. Projection from orthopyroxene (MS) onto the plane M_2S (olivine)- C_2S_3 - A_2S_3 . Phase boundaries are from O'Hara (1968). Ornamentation and lettering as in Fig. 8-7, except for the low-Mg mafic komatiites which are plotted as circles.

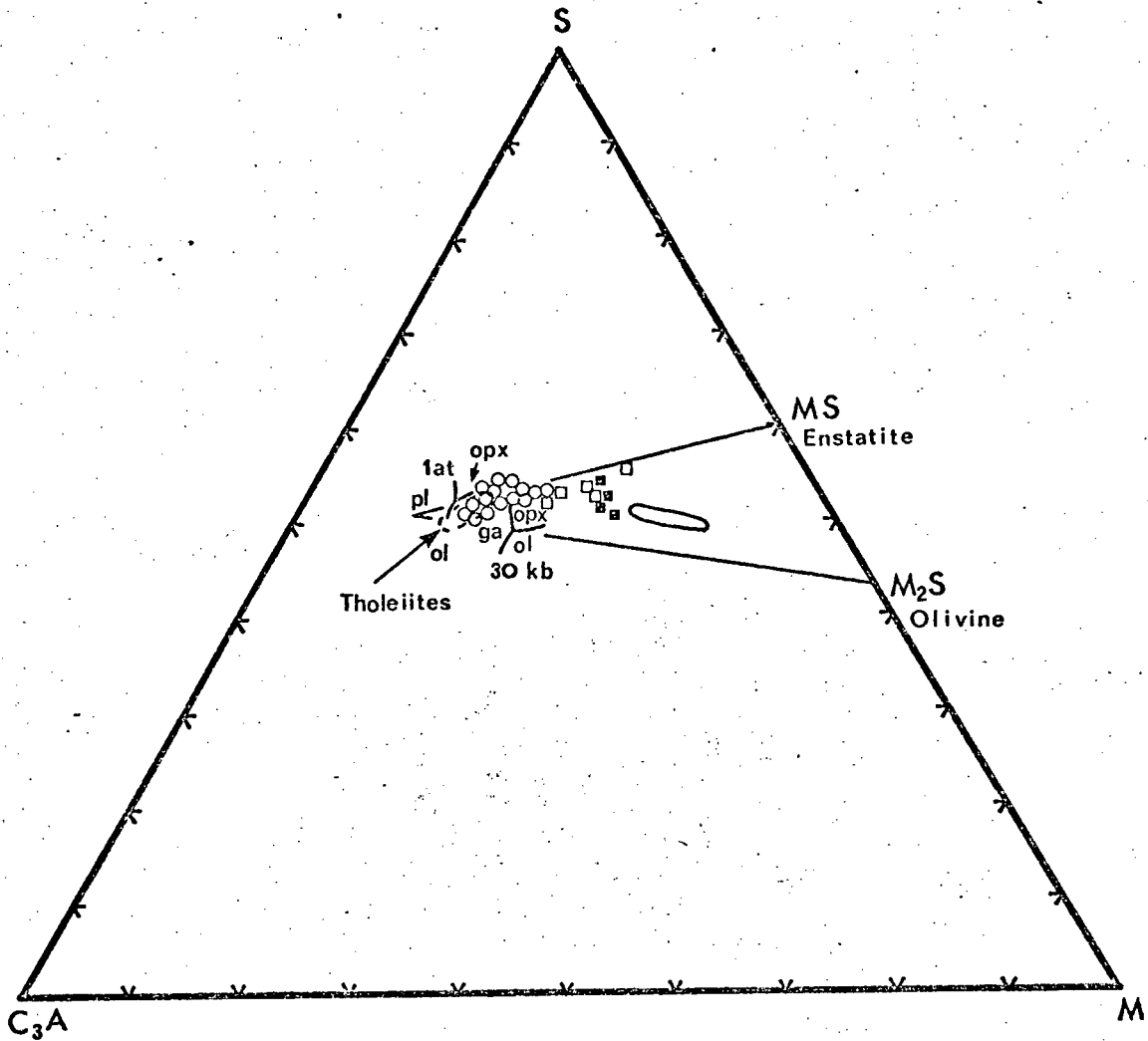


Fig. 8-9. Projection from diopside (CMS_2) onto the plane C_3A -M-S. Phase boundaries are from O'Hara (1968). The line from enstatite is the hypersthene-gabbo divide and the line from olivine is the olivine-gabbo thermal divide. Ornamentation and lettering as in Fig. 8-8, except both high-Ti and low-Ti tholeiites plot within the dashed field.