SOME ASPECTS OF THE GEOCHEMISTRY OF GALLIUM
IN SILICATE ROCKS AND STONY METEORITES

by

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Figures

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Background intensities at Ga Kα of some standard rocks, meteorites and doped blanks plotted against reciprocal m.a.c.

**FIG. 26.** Background intensities at Ga Kα of some standard rocks, meteorites and doped blanks plotted against reciprocal m.a.c.
FIG. 27. METEORITES.
MESOSIDERITES.

ACHONDRITES.

CHONDRITES.

ALL METEORITES.

FIG. 28. METEORITES.
CARBONACEOUS CHONDRITES.

HYPERSTHENNE CHONDRITES.

BRONZITE CHONDRITES.

ENSTATITE CHONDRITES.

ALL CHONDRITES.

FIG. 29. CHONDRITIC METEORITES.
CARBONACEOUS CHONDrites.

HYPERSTHENE CHONDrites.

BRONZITE CHONDrites.

ENSTATITE CHONDrites.

ALL CHONDrites.

FIG. 30. CHONDritic METEORites.
FIG. 31. CHONDRITIC METEORITES.
CARBONACEOUS CHONDrites C3-0.

N = 6

CARBONACEOUS CHONDrites C3-V.

N = 8

CARBONACEOUS CHONDrites C2.

N = 3

CARBONACEOUS CHONDrites.

N = 17

FIG. 32. CHONDritic METEORITES.
FIG. 33. CHONDRITIC METEORITES.
HYPERSTHENE CHONDRITES (NM FRACTION)

BRONZITE CHONDRITES (NM FRACTION)

FIG. 34. CHONDRITIC METEORITES.
EUCRITES.

HOWARDITES.

NAKHLITES.

UREILITES.

CHASSIGNITES.

AUBRITES.

ALL ACHONDRICTIC METEORITES.

FIG. 35. ACHONDRICTIC METEORITES.
EUCRITES.

HÉWARDITES.

NAKLHLITES.

UREILITES.

CHASSIGNITES.

AUBRITES.

ALL ACHONDRTIC METEORITES.

FIG. 36. ACHONDRTIC METEORITES.
KEY TO FIG. 37

☐ CARBONACEOUS CHONDrites.

▲ BRONZITE CHONDrites (H GROUP).

□ H GROUP, NON-MAGNETIC FRACTIONS.

◊ HYPERSTHENE CHONDrites (L GROUP).

☆ LL3 UNEQUILIBRATED CHONDRITE.

☆ LL6 AMPHOTERITES.

□ L GROUP, NON-MAGNETIC FRACTIONS.

☒ ENSTATITE CHONDrites.

☐ ENSTATITES, NON-MAGNETIC FRACTIONS.

☒ EUCRITE ACHONDrites.

☒ HOWARDITE ACHONDrites.

☒ NAKHLITE.

☒ UREILITE.

☐ DIOGENITES.

☑ AUBRITES.

+ CHASSIGNITE.

M MESOSIDERITES, NON-MAGNETIC FRACTIONS.

Φ MESOSIDERITES.

S MESOSIDERITES, SILICATE FRACTIONS.

◎ SHERGOTTITE.

◎ ANGRITE.
Fig. 38. A Ga-Fe plot for selected classes of meteorites. The area in which C3-V meteorites plot is shown, but the individual points are omitted.
Fig. 39. A Ga-Al-Fe ternary plot for all meteorites, ppm Ga (x4), % Al (x30) and % Fe (x1).
Fig. 40. Plots of Ga/Si - Al/Si, Ga/Si - Fe/Si, Ga/Si - C/Si and Ga/Si - S/Si for carbonaceous chondrites. Note: All ratios are atomic ratios.
Fig. 41. Ga - Fe and Ga - Al plots for enstatite chondrites and enstatite achondrites (aubrites).
Figs 42 - 72. Frequency distribution diagrams (histograms) of the Ga distributions (A) and Ga/Al distributions (B) for all rocks analysed in this work. In Figs 42 - 67, Q = quartz, A = alkali feldspar, P = plagioclase, F = felspathoids, M = mafic and related minerals. Tables 34 and 38 should be read in conjunction with these diagrams.
900000 METAMORPHIC ROCKS.

400000 SEDIMENTARY ROCKS.

300000 VOLCANIC ROCKS (CHEMICAL).

200000 VOLCANIC ROCKS (MINERALOGICAL).

100000 PLUTONIC & HYPABYSSAL ROCKS.

FIG. 42A. ALL ROCKS.
900,000 METAMORPHIC ROCKS.

400,000 SEDIMENTARY ROCKS.

300,000 VOLCANIC ROCKS (CHEMICAL).

200,000 VOLCANIC ROCKS (MINERALOGICAL).

100,000 PLUTONIC & HYPABYSSAL ROCKS.

Fig. 42B. ALL ROCKS.
FIG. 43A. PLUTONIC & HYPABYSSAL ROCKS.
190000 LAMPROPHYRES.

180000 ULTRAMAFIC ROCKS.

170000 F + A + P ROCKS.

160000 A + P + F ROCKS.

150000 A + P + F ROCKS.

FIG. 44A. PLUTONIC & HYPABYSSAL ROCKS.
FIG. 44B. PLUTONIC & HYPABYSSAL ROCKS.
FIG. 45A. GRANITIC ROCKS.
122900 FINE-GRAINED GRANITES.

122600 MÔNZÔGRANITES.

122200 GRANØPHYRES.

122000 GRANITES.

120000 Q + A + P ROCKS.

FIG. 45B. GRANITIC ROCKS.
FIG. 46A. A + P + Q ROCKS.
148000 ANORTHOSITES.

147000 GABBROID ROCKS.

146000 DIORITES.

143000 MONZONITES.

141000 ALKALI-FELDSPAR SYENITES.

140000 A + P - Q ROCKS.

FIG. 47A. A + P - Q ROCKS.
148000 ANORTHOSITES.  

147000 GABBROID ROCKS.  

146000 DIORITES.  

143000 MONZONITES.  

141000 ALKALI-FELDSPAR SYENITES.  

140000 A + P + - Q ROCKS.  

FIG. 47B.  A + P + - Q ROCKS.
147200 PLAG + PYX ROCKS.

147100 PLAG + PYX + OL ROCKS.

147000 GABBROID ROCKS.

FIG. 48A. GABBROID ROCKS.
147200 PLAG + PYX ROCKS.

147100 PLAG + PYX + OL ROCKS.

147000 GABBROID ROCKS.

FIG. 48B.  GABBROID ROCKS.
N = 17

PPM GA

1471E2 GABBRO-PICRITES.

N = 17

PPM GA

1471E1 OLIVINE FERROGABBROS.

N = 81

PPM GA

1471E0 OLIVINE GABBROS.

N = 89

PPM GA

147100 PLAG + PYX + OL ROCKS.

FIG. 49A. GABBROID ROCKS.
1471E2 GABBRO-PICRITES.

1471E1 OLIVINE FERROGABBROS.

1471EO OLIVINE GABBROS.

1471O0 PLAG + PYX + OL ROCKS.

FIG. 49B. GABBROID ROCKS.
1472AD DOLERITES.

147282 OPX FERROGABBROS.

147280 GABBROS.

147220 NØRITES.

147200 PLAG + PYX ROCKS.

FIG. 50A. GABBROID ROCKS.
1472AD DOLERITES.

147282 FERROGABBROS.

147280 GABBROS.

147200 PLAG + PYX ROCKS.

FIG. 50B. GABBROID ROCKS.
157300 NEPH-BEARING OL GABBROS.

157000 FOID-BEARING GABBROS.

152000 FOID-BEARING SYENITES.

150000 A + P +/- F ROCKS.

FIG. 51A. A + P +/- F ROCKS.
157300 NEPH-BEARING OL GABBROS.

157000 FOID-BEARING GABBROS.

152000 FOID-BEARING SYENITES.

150000 A + P +- F ROCKS.

FIG. 51B. A + P +- F ROCKS.
FREQUENCY

PPM GA

183000 OL + PYX + PLAG ROCKS.

FREQUENCY

PPM GA

181600 HARZBURGITES.

FREQUENCY

PPM GA

181200 PYROXENITES.

FREQUENCY

PPM GA

181000 OL + PYX ROCKS.

FREQUENCY

PPM GA

180000 ULTRAMAFIC ROCKS.

FIG. 53A. ULTRAMAFIC ROCKS.
FIG. 53B. ULTRAMAFIC ROCKS.
187400 NON-MICA CARB.-RICH KIMBERLITE.

187300 CARBONATITIC KIMBERLITE.

187200 NON-MICACEOUS KIMBERLITES.

187100 MICA-RICH KIMBERLITES.

187000 KIMBERLITES.

FIG. 54A. KIMBERLITES.
187400 NON-MICA CARBONATE-RICH KIMBERLITES.

187300 CARBONATITIC KIMBERLITES.

187200 NON-MICACEOUS KIMBERLITES.

187100 MICA-RICH KIMBERLITES.

187000 KIMBERLITES.

FIG. 54B. KIMBERLITES.
FIG. 55A. KIMBERLITIC XENOLITHS.
FIG. 55B.  KIMBERLITIC XENOLITHS.
230000 A + P + Q ROCKS.

220000 Q + A + P ROCKS.

210000 GLASSY ROCKS.

200000 VOLCANIC ROCKS.

FIG. 56A. VOLCANIC ROCKS.
FIG. 56B. VOLCANIC ROCKS.
290000 FRAGMENTAL ROCKS.

280000 ULTRAMAFIC ROCKS.

270000 F + - A + - P ROCKS.

260000 A + P + F ROCKS.

250000 A + P + - F ROCKS.

240000 A + P + - Q ROCKS.

FIG. 57A. VOLCANIC ROCKS.
Fig. 57B. Volcanic Rocks.
224000 DACITES.

222000 RHYOLITES.

220000 Q + A + P ROCKS.

FIG. 58B. Q + A + P ROCKS.
246000 ANDESITES.

245000 LATITE BASALTS.

244000 LATITE ANDESITES.

243000 LATITES.

242000 TRACHYTES.

241000 ALKALI TRACHYTES.

240000 A + P + Q ROCKS.

FIG. 59A. A + P + Q ROCKS.
246000 ANDESITES.

245000 LATITE BASALTS.

244000 LATITE ANDESITES.

242000 TRACHYTES.

241000 ALKALI TRACHYTES.

240000 A + P +- Q ROCKS.

FIG. 59B. A + P +- Q ROCKS.
247200 PLAG + PYX ROCKS.

N = 160

247100 PLAG + PYX + OL ROCKS.

N = 22

247000 BASALTIC ROCKS.

N = 173

FIG. 60B. BASALTIC ROCKS.
247111 PICRITIC BASALTS.

247110 OLIVINE BASALTS.

247100 PLAG + PYX + OL ROCKS.

FIG. 61A. PLAG + PYX + OL ROCKS.
247111 PICRITIC BASALTS.

247110 OLIVINE BASALTS.

247100 PLAG + PYX + OL ROCKS.

FIG. 61B. PLAG + PYX + OL ROCKS.
247220 BASALTS.

247210 THOLEIITE BASALTS.

247200 PLAG + PYX ROCKS.

FIG. 62A. PLAG + PYX ROCKS.
247220 BASALTS.

247210 THOLEIITE BASALTS.

247200 PLAG + PYX ROCKS.

FIG. 62B. PLAG + PYX ROCKS.
FIG. 63A. FOID-BEARING BASALTIC ROCKS.
FIG. 63B. FOID-BEARING BASALTIC ROCKS.
312000 CALC-ALKALINE TYPE.

311000 THOLEIITIC TYPE.

310000 SUBALKALINE ROCKS.

FIG. 64A. VOLCANIC ROCKS.
FIG. 65A. SUBALKALINE THOLEIITIC ROCKS.

BASALTIC KOMATIITES (GELUK TYPE).

BASALTIC KOMATIITES (BADPLAAS TYPE).

BASALTIC KOMATIITES (BARBERTON TYPE).

311700 ALL BASALTIC KOMATIITES.

311600 PERIDOTITIC KOMATIITES.

311000 SUBALK. THOLEIITIC ROCKS.
Fig. 65B. Subalkaline tholeiitic rocks.
312400 DACITES.

312000 CALC-ALKALINE ROCKS.

FIG. 66B. CALC-ALK SUBALKALINE ROCKS.
286000 SERPENTINITES.

283000 OL + PYX + PLAG ROCKS.

281100 LIMBURGITES.

280000 ULTRAMAFIC ROCKS.

FIG. 67A. ULTRAMAFIC ROCKS.
FIG. 68A. SHALES.
FIG. 68B. SHALES.
7N1300 HYPERSTHENES.

7NO000 ALL PYROXENES.

7MA100 PERTHITIC FELDSPARS.

7M2000 PLAGIOCLASE FELDSPARS.

7P2100 BIOTITES.

700000 ALL MINERALS.

FIG. 69A. MINERALS.
7NO000 PYROXENES.

PERTHITIC FELDSPARS.

BIOTITES.

700000 ALL MINERALS.

FIG. 69B. MINERALS.
7D1200 MAGNETITES.

7DH000 CHROMIUM SPINELS.

7E1100 ILMENITES.

7Q4000 GARNETS.

7Q000 ALL MINERALS.

FIG. 70A. MINERALS.
704000 CHROMIUM SPINELS.

704000 GARNETS.

700000 ALL MINERALS.

FIG. 70B. MINERALS.
CONTINENTAL BASALTIC ROCKS.

N = 90

OCEANIC BASALTIC ROCKS.

N = 187

ALL BASALTIC ROCKS.

N = 276

FIG. 71A. BASALTIC ROCKS.
CONTINENTAL BASALTIC ROCKS.

OCEANIC BASALTIC ROCKS.

ALL BASALTIC ROCKS.

FIG. 71B. BASALTIC ROCKS.
CONTINENTAL BASALTS.

OCEANIC BASALTS.

CONTINENTAL THOLEIITES.

OCEANIC THOLEIITES.

ALL PLAG + PYX ROCKS.

FIG. 72A. BASALTIC ROCKS.
FIG. 73. GA-AL PLOT FOR THOLEIITE BASALTS.

- **BARBERTON ROCKS.**
- **X** MID-ATLANTIC RIDGE.
- **Y** PACIFIC OCEAN. ABYSSAL ROCKS.
- **X** CARLSBERG RIDGE.
- **X** JOIDES LEG 25 INDIAN OCEAN.
- **O** ICELAND.
- **O** GALAPAGOS ISLANDS.
- **A** HAWAIIAN ISLANDS.
Fig. 74. A Ga - Al plot for oceanic island and continental basalts.
Fig. 75. A Ga - Al and Ga - (Al + Fe$^3$) plot for rocks from the Doros Igneous Complex, S.W.A.
Fig. 76. Ga - Al and Ga - (Al + Fe³) plots for rocks from the Erongo (S.W.A.) and Losberg (Transvaal) Igneous Complexes.
Fig. 77. Ga-Al and Ga-(Al+Fe\textsuperscript{3+}) plot for anorthosites from the Kunene Basic Complex, S.W.A.
Fig. 78. Ga - Al and Ga - (Al + Fe³) plots for mica-rich kimberlites and for xenoliths from the Matsoku Pipe.
Fig. 79. Ga - Al and Ga - (Al + Fe$^3$) plots for gabbro-picrites and olivine gabbros from the Tholeiitic Series, Okonjeje Igneous Complex, S.W.A.
OKONJEJE - THOLEIITIC SERIES

Fig. 80. Ga - Al and Ga - (Al + Fe³) plots for olivine ferrogabbros, hypersthenes ferrogabbros, pyroxene diorites, monzonites and adamellites, and alkali syenites from the Tholeiitic Series, Okonjeje Igneous Complex, S.W.A.
Fig. 81. Ga - Al and Ga - (Al + Fe³) plots for granulitised alkali olivine gabbros and alkali olivine gabbros from the Alkali Series, Okonjeje Igneous Complex, S.W.A.
Fig. 82. Ga - Al and Ga - (Al + Fe³) plots for nepheline olivine gabbros and melteigites and camptonites from the Alkali Series, Okonjeje Igneous Complex, S.W.A.
Fig. 83. Ga - Al and Ga - (Al + Fe$^{3+}$) plots for rocks from Bouvetoya Island and from Gough Island.
Fig. 84. Map indicating locations of rocks from abyssal sites and islands in which Ga has been determined in this work. Stippled areas indicate oceanic rise and ridge systems. (After Engel et al., 1965)
ABYSSAL INDIAN THOLEIITES.

ABYSSAL PACIFIC THOLEIITES.

ABYSSAL ATLANTIC THOLEIITES.

ALL OCEANIC THOLEIITES.

**FIG. 85A.** OCEANIC THOLEIITES.
Fig. 86. Drill sites for DSDP Leg 25 in the western Indian Ocean.
Fig. 87. Plot of Ga and Ga/Al ratio against differentiation index for rocks from islands in the Atlantic Ocean.
Fig. 88B. Plot of Ga and Ga/Al ratio against D.I. for rocks from islands in the Pacific Ocean.
Fig. 90A. Plot of Ga against SiO$_2$ for rocks, for which D.I.'s were not known, from islands in the Atlantic Ocean.
Fig. 90B. Plot of Ga against SiO$_2$ for rocks, for which D.I.'s were not known, from islands in the Atlantic Ocean.
PACIFIC & INDIAN OCEAN ISLANDS

Fig. 91. Plot of Ga against SiO$_2$ for rocks, for which D.I.'s were not known, from islands in the Pacific and Indian Oceans.
Fig. 92. Plot of Ga, Ga/Al ratio and $D_{Ga}^{ plag}$ against percent Anorthite for plagioclases from basic lavas (data from Goodman, 1972).
Fig. 93. Plot of Ga against Al for rocks from Marion and Prince Edward Islands, Indian Ocean.
Fig. 94. Map of southern Africa showing the locations and extent of some intrusive bodies in Rhodesia, Transvaal and Orange Free State (after Davies et al., 1970).
Fig. 95. Geological map of the Vredefort Dome area showing the location of the Losberg Intrusion (from Danchin and Ferguson, 1970).
Fig. 96. Variation of major element oxides with height in the Losberg Intrusion (from Danchin and Ferguson, 1970).
Fig. 97. Variation of trace elements with height in the Losberg Intrusion (from Danchin and Ferguson, 1970).
Fig. 98. Plots of Ga, Al, Ga/Al ratio and D.I. against height in the Losberg Intrusion, and plots of Ga - D.I., Ga/Al - D.I. and Ga - Al.
Fig. 99. FMA diagram for rocks from the Komatiport Intrusion. Data from A.J. Erlank (pers. comm.).
Fig. 100. Ga - D.I. and Ga/Al - D.I. plots for rocks from the Komatipoort Intrusion.
Fig. 101. Map of the B.I.C. showing locations of chromite and magnetite samples analysed in this work (map from Wager and Brown, 1968).
Fig. 102. Ga/Al ratios plotted against the altered Larsen function for rocks from the B.I.C. Data taken from Liebenberg (1960). Data for rocks from the Skaergaard Intrusion are included for comparison.
Fig. 103. Plots of Ga, Ga/Al and Ga/(Al + Fe³) against D.I. for rocks from the Skaergaard Intrusion. Data from this work.
Fig. 104. Plots of Ga/Al and Ga/(Al + Fe$^3$) for rocks from the Skaergaard Intrusion, showing combined data from this work and Vincent and Nightingale (1974).
Fig. 105. Sketch map showing the distribution of post-Karroo igneous complexes (solid black) and Karroo sediments and lavas (stippled) in northern Damaraland, S.W.A., and the locations of some granite samples (after Simpson, 1954).
Fig. 106. Geological map of the Okonjeje Igneous Complex, S.W.A., from Simpson (1954).
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<th>Stratigraphic Sequence</th>
<th>Olivine Composition</th>
<th>Sample Number</th>
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Fig. 107. Schematic representation of the layered tholeiitic series and its dyke equivalents, Okonjeje Igneous Complex (after Fesq, pers. comm.).
Fig. 108. Plot of Ga data from this work against those from Simpson (1954) for rocks from the Okonjeje Igneous Complex.
Plots of Ga and Ga/Al ratio against D.I. for all rocks from the tholeiitic and alkali series and granites from the Okonjeje Igneous Complex.

**KEY:**

**Tholeiitic Series**
- Mafic cumulates (gabbro-picrites)
- Olivine gabbros (Ridge gabbros)
- Olivine ferrogabbros
- Ferrogabbros
- Alkali syenites
- Quartz syenites
- Marginal acid rocks
- Plagioclase cumulate

**Alkali Series**
- Contaminated olivine gabbros
- Olivine gabbros (Core gabbros)
- Nepheline olivine gabbros
- Melteigites
- Lamprophyres
- Essexites and pulaskites
- Foyaites and tinguaites
- Granites
Fig. 109. Plots of Ga and Ga/Al ratio against D.I. for all rocks from the tholeiitic and alkali series of the Okonjeje Igneous Complex.
Fig. 110. Plots of mean values for Ga and the Ga/Al ratio against D.I. for individual rock types from the tholeiitic and alkali series of the Okonjeje Igneous Complex. Key: as for Fig. 109.
Fig. 111. Plots of Ga and Ga/Al ratio against D.I. for rocks from the Doros and Erongo Igneous Complexes, S.W.A.
Fig. 112. Plot of Ga against Al, and Ga/Al distribution for granites from S.W.A.
A map of the kimberlite localities in Southern Africa which contain non-cryptic ultramafic xenoliths.

Locality Numbers:

Inset map of Kimberley Area:

Orange Free State:

Transvaal:
44. De Deopoor, 45. Pretor, 46. Zonderwater, 47. Montrose No. 2.

Lesotho:

Inset Map of Maluti Mountains:

Rhodesia:
63. Motat, 64. Weesels, 65. Colesaa.

South West Africa:

Tanzania:
68. Sultan, 69. Masork.

Fig. 113B. Map of kimberlite localities in southern Africa and Tanzania.
(From Rickwood, 1969)
Fig. 114. Ga-Al plots for veined and unveined rocks from the Matsoku kimberlite pipe, Lesotho.

**KEY:**

**Veined rocks**
- Garnet lherzolite (CP)
- Pyroxenite
- Cpx-rich zone
- Opx-rich zone
- Other zones

**Unveined rocks**
- Garnet lherzolite (CP)
- Pyroxenite
- Orthopyroxenite
- Eclogite and amphibolite
- Kimberlite
Fig. 114. Ga - Al plots for veined and unveined rocks from the Matsoku kimberlite pipe, Lesotho.
Cross-section sketch diagrams of veined nodules from Matsoku Pipe.

LBM 33 A: coarse banded pyroxenite; 4% olivine, 40% opx, 33% Cr-diopside, 23% garnet (by volume)

LBM 33 B: coarse banded pyroxenite; 14% olivine, 72% opx, 7% Cr-diopside, 7% garnet

LBM 33 C: coarse banded pyroxenite; 14% olivine, 21% opx, 49% Cr-diopside, 16% garnet

LBM 36 A: coarse banded pyroxenite; 54% olivine, 23% opx, 12% Cr-diopside, 11% garnet

LBM 36 B: coarse banded pyroxenite; 34% olivine, 8% opx, 44% Cr-diopside, 14% garnet

LBM 38 A: coarse CP; 67% olivine, 23% opx, 2% Cr-diopside, 8% garnet

LBM 38 B: even textured, gneissose pyroxenite; 14% olivine, 47% opx, 24% Cr-diopside, 6% garnet, 7% ore

LBM 88 b.a.2: garnet lherzolite (CP)
  b.a.1: opx- and cpx-rich vein or sheet
  b.a.3: garnet lherzolite (CP)

LBM 90 b.a.2: garnet lherzolite (coarse CP), 'host'
  b.a.3: 'upper' marginal cpx-rich zone
  b.a.4: 'upper' inner cpx-poor ol-rich zone
  b.a.5: 'lower' inner cpx-poor opx-rich zone
  b.a.6: 'lower' marginal cpx-rich zone
  b.a.1: whole of sheet, composite of b.a.2-6

Diagrams from J.J. Gurney (pers. comm.).
Fig. 115. Sketches of veined nodules from Matsoku Pipe.
Fig. 116. Cross-section sketch diagrams of veined nodules from Matsoku Pipe.

LBM 87 b.a.1: fine-grained garnet lherzolite (CP) unusually rich in garnet and opx
b.a.2: porphyroblastic (flaser) garnet lherzolite (CP) adjacent to b.a.1
b.a.3: porphyroblastic garnet lherzolite (CP) away from b.a.1

LBM 101 b.a.1: 'host' garnet lherzolite (CP)
b.a.2: metasomatic vein containing phlogopite, ilmenite and rutile in addition to ol, opx and cpx

LBM 131 b.a.2: cpx-rich marginal zone of presumed sheet
b.a.3: inner zone richer in opx and olivine
b.a.1: whole cross-section of cpx-rich sheet

LBM 139 CP: 'host' garnet lherzolite (coarse CP) (not available for analysis)
b.a.2: cpx-rich marginal zone of sheet
b.a.3: inner zone, fairly rich in opx with moderate cpx, some olivine and very little garnet
b.a.1: whole of sheet

Diagrams from J.J. Gurney (pers. comm.).
Fig. 116. Sketches of veined nodules from Matsoku Pipe.
Plots of Ga, Al, Ga/Al ratio and \( \text{Cr}_2\text{O}_3 \) against Mg number \((100 \text{MgO} / (\text{MgO} + \text{FeO}^*))\) for some Matsoku nodules. FeO* is total Fe expressed as FeO. Mg numbers and \( \text{Cr}_2\text{O}_3 \) data from Dr. J.J. Gurney (pers. comm).

**KEY:**
- ○ garnet lherzolites (CP) - depleted
- ○ garnet lherzolites (CP) - flaser texture
- □ metasomatised garnet lherzolites (CP)
- ● cumulate pyroxenites
- ■ CP in contact with cpx-rich sheets
- △ cpx-rich margins in contact with cpx-rich sheets
- ✶ inner zones of cpx-rich sheets
- ▼ complete sections across cpx-rich sheets
- + veins
Fig. 117. Plots of Ga, Al, Ga/Al ratio and Cr\textsubscript{2}O\textsubscript{3} against Mg number for some Matsoku nodules.
Fig. 118. A plot of Ga against Al for xenoliths from kimberlite pipes other than Matsoku.

**KEY:**

- Roberts Victor eclogites
- Roberts Victor eclogites, Ca-rich (1 or 2 = class I or II)
- Roberts Victor eclogites, Mg-rich
- Roberts Victor eclogites, Fe-rich
- Rietfontein pipe
- Bultfontein pipe, garnet lherzolites and harzburgites
- Bultfontein pipe, richterite and phlogopite peridotites
- Jagersfontein pipe
- Monastery Mine
- De Beers Mine
- Kamfersdown Mine
- Tanzanian eclogites
- Kyanite eclogite
- Corundum eclogite
- Clinopyroxene megacryst
- Ilmenite megacryst
- Garnet megacryst
- Eclogitic garnet
A plot of Ga against Al for kimberlites from southern Africa, most of which are contaminated with crustal rocks.
Fig. 120. Plots of Ga against Al for kimberlites from southern Africa specially selected to be free from crustal contamination, and for some Lesotho kimberlites.
Fig. 121. The distribution and stratigraphy of the Swaziland Sequence in the Barberton Mountain Land, South Africa (from Anhaeusser, 1973).
SAMPLE LOCALITIES

Fig. 122. Geological map of the granitic rocks of the Barberton region showing localities (underlined) of rocks analysed in this work.
Fig. 123. Plot of Ga against Al for rocks from the Barberton Mountain Land.

KEY:

△ Peridotitic komatiite
▲ Basaltic komatiite, Geluk type
▼ Basaltic komatiite, Badplaas type
● Basaltic komatiite, Barberton type, massive
○ Basaltic komatiite, Barberton type, pillow margin
(⊙ = epidotised)
★ Basaltic komatiite, Barberton type, pillow core
■ Metatholeiite
▼ Metabasalt
✚ Acid intrusives
▼ Intermediate lava
▼ Andesite
★ Acid lava
Fig. 123. Plot of Ga against Al for rocks from the Barberton Mountain Land.
Plots of average values of Ga - Al, Ga - D.I., Ga/Al - D.I. for the main rock types from the Barberton Mountain Land. Ga - Al plots are included for rocks sampled vertically across two flows. Key as for Fig. 123.
Fig. 125. A Ga/Al - D.I. plot for individual samples from the Swaziland Sequence, Barberton Mountain Land. Key as for Fig. 123.
Fig. 126. Ga-Al plots for rocks sampled along flows. Data from this work and Condie et al. (1977). Data are also plotted for core-margin pairs from lava pillows. CE = Condie, epidotised flow; CC = Condie, carbonated flow; CU = Condie, unaltered flow; TU = this work, unaltered flow.
Fig. 127. Simplified geological map of southern Africa showing sample locations of Karroo-Stormberg volcanic rocks (after Erlank, 1971).

1. Central area
2. Southern Lebombo
3. Nuanetsi
4. Northern Province
   A. Tuli
   B. Featherstone
   C. Nyamandhlovu
   D. Wankie
   E. Botswana
5. Southern South West Africa
6. Northern South West Africa (Etendeka plateau)
Fig. 127. Simplified geological map of southern Africa showing sample locations of Karroo-Stromberg volcanic rocks (after Erlank, 1971).
Fig. 128. Ga - Al, Ga - D.I. and Ga/Al - D.I. plots for Karroo rocks from South Africa, Swaziland and South West Africa. Dotted area = Umkondo dolerites (see text and Fig. 130).
Fig. 129. Ga - Al, Ga - D.I. and Ga/Al - D.I. plots for Karroo rocks from Rhodesia and Botswana (Northern Province) excluding those from the Nuanetsi Igneous Province.
Fig. 130. Ga-Al, Ga-D.I. and Ga/Al-D.I. plots for all rocks from the Northern Karroo Province and the Umkondo dolerites.
Fig. 131. A simplified geological map of Brazil indicating the distribution of the Parana volcanics and sample localities (from Erlank, 1971).
Fig. 132. Ga - Al, Ga - D.I. and Ga/Al - D.I. plots for Brazilian (Parana) volcanic rocks.
Fig. 133. A Ga-Al plot for all Karroo rocks from southern Africa and Brazil.
Fig. 134. Frequency distribution diagrams of the Ga/Al ratio in Karroo rocks from southern Africa and Brazil.
FIG. 135. GR - AL PLOT FOR CONTINENTAL BASALTS.
Fig. 136. Sample sites of granites in the Cape Peninsula (from Brunke, 1973).
Fig. 137. Location of sample sites of sedimentary rocks from the Malmesbury Series, Cape Province, South Africa.
MALMESBURY SEDIMENTS

- argillaceous
- clay fraction
+ arenaceous
- clay fraction

Fig. 138. Ga - Al, Ga/Al - Al and Al - W.I. (weathering index) plots for Malmesbury sediments and separated clay fractions.
Fig. 139. Sketch diagrams showing the location and general geology of the Sea Point contact, Cape Town, South Africa (from Walker and Mathias, 1947).
Fig. 140. Sketch map giving sample localities and geological details of the Sea Point contact zone (after van Coller, 1958).
Fig. 141. Ga - Al plots for rocks from the Sea Point contact, and a comparison between optical emission spectrographic (Erlank, pers. comm.) and XRF Ga data for rocks from the area.
Fig. 142. Location and schematic section of the Kunene Basic Complex, Kaokoveld, S.W.A. (from Köstlin, 1967).
Fig. 143. Ga - Al, Ga - D.I. and Ga/Al - D.I. plots for rocks from the Kunene Basic Complex.
Fig. 144. Map showing location of Oldoinyo Lengai, Tanzania (from Dawson, 1966).
Fig. 145. Ga - Al, Ga - D.I. and Ga/Al - D.I. plots for rocks from Oldoinyo Lengai.
Fig. 147. Geological map of the Nejoio area, Angola (after Rodrigues, 1973).
Fig. 148. Plots of Ga and Ga/Al ratio against E.I. (endofenitization index, see text) for rocks from the Nejoio Ring Complex, Angola.

KEY:
- S1, amphibole-nepheline syenites
- S2, nepheline-amphibole-pyroxene syenites
- S3, nepheline-cancrinite-pyroxene syenites
- S4, nepheline syenites
- S5, nepheline-cancrinite-hackmanite syenites
- S6, cancrite-hackmanite syenites
- PT, phonolites and tinguaites
- AT, alkali trachytes
- dolerites
- cone-sheet (eruptive) breccias
Fig. 148. Plots of Ga and Ga/Al ratio against E.I. (endoenitization index, see text) for rocks from the Nejoio Ring Complex, Angola.
Fig. 149. A Ga - Al plot for rocks from the Nejoio Ring Complex. Key as for Fig. 148.
Figure 150. Plot of mean values of Ga, Al and Ga/Al ratio for different rock types from the Nejoio area, Angola. Keys as for Figs 148 and 151.
Fig. 151. Ga - F.I. (fenitisation index, see text) and Ga/Al - F.I. plots for fenites from the Nejoio area, Angola.