

MINERALOGY, PETROLOGY AND PETROGENESIS OF THE KIMBERLITE
FROM SOMERSET ISLAND, N.W.T., CANADA

D.B. Clarke, Dalhousie University, Halifax, N.S., Canada

R.H. Mitchell, Lakehead University, Thunder Bay, Ont., Canada

Mitchell and Fritz (1973) have given the first general description of the location, tectonic setting and mineralogy of the Somerset Island kimberlite. This paper deals with the mineralogy and texture in detail, interprets the crystallization history and speculates on the petrogenetic evolution of this occurrence of kimberlite.

The primary crystallization products are tabulated below:

<u>Name</u>	<u>Approx. Mode</u>	<u>Pheno-cryst</u>	<u>Ground-mass</u>	<u>Composition or Compositional Range</u>
Olivine	35	X	X	Fo ₉₀ -Fo ₈₈
Garnet	1	X		Gr ₁₂ Py ₆₅ Al ₁₅ Sp ₁ Uv ₇
Phlogopite	1	X	X	Phl ₈₉ Ann ₁₁
Ilmenite	<1	X		Ilm ₅₃ Geik ₄₇ -Ilm ₁₀₀
Chromite	2	X	X	Chr ₇₅ Sp ₂₅
Red Chrome Spinel	<1	X		Chr ₆₀ Sp ₄₀
'Magnetite'	<1	X		Mt ₉₈ Usp ₂ -Mt ₆₀ Usp ₄₀
Perovskite	2		X	FeO 1.5%, Nb ₂ O ₅ 0.3-0.9%
Rutile	1	X	X	
Pyrite	<1		X	Ni 0-7%
Heazlewoodite	<1		X	Fe 1-2%
Chalcopyrite	<<1		X	
'Native Silver'	<<1		X	Ag 91%, Co 0.01% Ni 0.1%, Fe 1%
Carbonate Groundmass	15		X	MgO = 17%, FeO 3%
Silicate Groundmass	35		X	

Secondary minerals include serpentine, chlorite and minor magnetite. In addition, there are single crystals of enstatite-bronzite and clinopyroxene which may be xenocrysts and a long list of xenoliths including monomineralic phlogopite aggregates, highly altered eclogite(?), lherzolite and many other assemblages including various combinations of phlogopite, clinopyroxene, serpentine, chlorite, oxides, sulphides, carbonate and apatite. Also, there are at least three distinctly different types of Palaeozoic sedimentary carbonate xenoliths.

There is considerable textural evidence for the formation of an immiscible carbonate liquid at some intermediate stage in the crystallization of the kimberlite. There is intimate mixing of carbonate and microcrystalline silicates in the groundmass ranging from isolated blebs of carbonate in the silicate groundmass to isolated blebs of silicate in the carbonate groundmass. The carbonate groundmass is not believed, on compositional or on textural grounds, to be in any way related to the xenoliths of sedimentary carbonate rocks, all of which show sharp contacts with both the silicate and carbonate groundmasses.

The most striking textural feature is the wide variety of epitaxial zoning displayed by the late-stage primary minerals where rapid rates of crystallization have prevailed. These zonations include the following sequences (core to rim):

- 1) olivine - perovskite + serpentine - rutile
- 2) magnesian ilmenite - serpentine + rutile - perovskite - rutile*
- 3) chromite - carbonate - perovskite - rutile - (±heazlewoodite)
- 4) chromite - "spinel" - perovskite*
- 5) magnetite - ulvospinel - ilmenite*
- 6) red spinel - opaque - carbonate - rutile
- 7) heazlewoodite - pyrite

(*Chemical analyses are given in Table 1 for parts of sequences indicated above.)

Except for the sulphides, all zonations are towards increasing TiO_2 and must reflect a late-stage concentration of titanium in the silicate liquid.

The sequence of crystallization may be generalized as follows: Pre-Fluidization - red spinel, phlogopite, garnet, olivine, possibly some of the large rounded chromites, and the extensive reaction rims of the phlogopites and garnets.

Post-Fluidization - all other minerals listed above as groundmass, including the euhedral groundmass chromites with epitaxial zoning. The one important mineral not easily assigned to a position in the crystallization sequence is the magnesian ilmenite. The continuous zoning from a highly magnesian central region outwards to a lower magnesian edge suggests that these crystals grew in an environment of high but rapidly decreasing pO_2 , or high but rapidly decreasing MgO , or both. The restricted occurrence of magnesian ilmenite in the silicate groundmass, its variable composition and the apparent late-stage concentration of TiO_2 in the silicate groundmass, all suggest a Post-Fluidization origin for these grains. However, the crystals are anhedral and do not have their magnesian 'core' in the centre of the grains. This might indicate a Pre-Fluidization origin followed by magmatic corrosion and mantling by such Post-Fluidization minerals as perovskite and rutile.

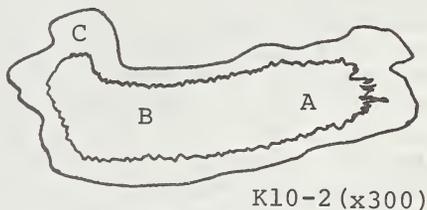
Two of the most important problems still to be resolved are the very late-stage concentration of nickel, as evidenced by the epitaxial zones of heazlewoodite on the chrome spinels, and the enigmatic existence of native silver which occurs as common isolated grains in the silicate groundmass.

Reference: Mitchell, R.H. and Fritz, P.
Canadian J. Earth Sci. 10, 384-393, 1973.

(Table 1 overleaf)

ZONED MAGNESIAN ILMENITE-PEROVSKITE

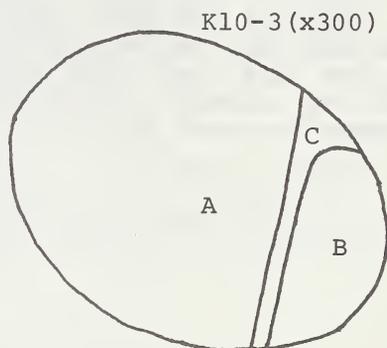
	<u>K10-2A</u>	<u>K10-2B</u>	<u>K10-2C</u>
TiO ₂	58.45	57.45	54.93
ZrO ₂	0.00	0.00	0.08
Al ₂ O ₃	0.06	0.06	0.44
Cr ₂ O ₃	0.02	0.03	0.00
FeO	26.17	30.88	1.39
MnO	0.65	0.58	0.00
MgO	13.46	10.66	0.14
NiO	0.05	0.04	0.01
CaO	0.29	0.30	35.00
Nb ₂ O ₅	0.10	0.10	0.71
	<u>99.25</u>	<u>100.10</u>	<u>92.70</u>



K10-2 (x300)

ZONED MAGNETITE-ULVOSPINEL-ILMENITE

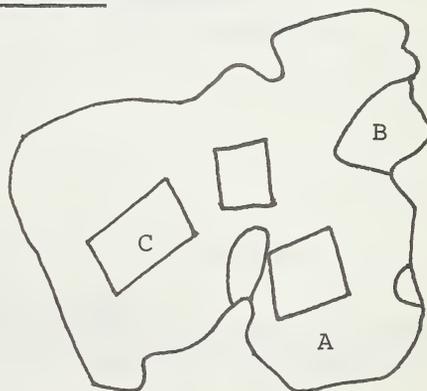
	<u>K10-3A</u>	<u>K10-3C</u>	<u>K10-3B</u>
SiO ₂	-	0.31	-
TiO ₂	1.16	19.41	53.42
ZrO ₂	0.03	-	0.00
Al ₂ O ₃	0.45	1.37	0.08
Cr ₂ O ₃	0.11	0.02	0.01
Fe ₂ O ₃	66.05	27.66	1.39
FeO	31.14	44.49	41.41
MnO	0.24	0.75	1.29
MgO	0.34	1.97	3.60
NiO	0.10	-	0.02
CaO	0.17	0.25	0.17
Nb ₂ O ₅	0.02	-	0.05
	<u>99.81</u>	<u>96.23</u>	<u>101.44</u>



K10-3 (x300)

ZONED CHROME SPINEL-"SPINEL"-PEROVSKITE

	<u>K10-4C</u>	<u>K10-4A</u>	<u>K10-4B</u>
TiO ₂	5.10	13.25	55.35
ZrO ₂	-	0.00	0.09
Al ₂ O ₃	11.29	9.72	0.42
Cr ₂ O ₃	43.77	0.19	0.00
Fe ₂ O ₃	7.44	38.33	-
FeO	18.66	21.54	1.71
MnO	0.34	0.43	0.00
MgO	12.64	13.94	0.13
NiO	-	0.13	0.03
CaO	0.10	0.95	37.06
Nb ₂ O ₅	-	0.00	0.89
	<u>99.34</u>	<u>98.48</u>	<u>95.68</u>



K10-4 (x450)

Table 1