PARTIAL MELTS IN UPPER MANTLE NODULES FROM LABRADOR KIMBERLITES

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Recent mapping at Saglek, northern Labrador, has revealed the presence of several kimberlite dykes which cut early Achaean gneisses and contain rounded ultramafic inclusions up to 2 cm in diameter. The kimberlite is a dense melanocratic megacrystic rock. It consists predominantly of randomly distributed rounded to subangular megacrysts or glommeromegacrystic aggregates of olivine up to 4 mm diameter in a fine grained matrix with a pronounced fluidal texture resulting from aligned phlogopite crystals. The megacrysts range in composition from $Fo_{87.5}$ to Fo_{90} and are extremely homogeneous with less than 1 wt. % variation in MgO and a slight variation in NiO (0.16 to 0.11 wt.%) from core to rim. In contrast, the groundmass olivines are slightly more iron rich and display a range in composition from $Fo_{86.5}$ to $Fo_{87.7}$. Both groundmass and megacrystic olivines have low concentrations of CaO, viz. 0.04 to 0.15 wt. % and 0.05 to 0.13 wt. % respectively. According to Simkin and Smith (1970) and Mitchell (1973) low calcium content in olivine implies a deep seated crystallisation environment. This is not surprising, despite the fact that the magma was moderately lime rich (Table 1) as the chemical potential of CaO in the liquid remained relatively high until late in the crystallisation history of the dyke when diopside, perovskite and calcite became solidus phases. The olivines display a similar range in composition to olivines from other kimberlites which display magmatic crystallisation textures. The slightly more forsteritic nature of the megacrysts relative to the matrix olivines in the Saglek kimberlites suggests that they are earlier crystallisation products from the kimberlite magma. The matrix also contains abundant Ti-phlogopite with TiO_2 contents ranging from 3.73 to 4.78 wt. % and Mg values between 81.95 and 85.9. The phlogopites are generally more titaniferous than micas reported previously from kimberlites, their higher values of TiO_2 being more typical of titaniferous phlogopites from glimmerite nodules. Other matrix minerals include Cr-poor diopside, spinel, magnesium rich ilmenite and melilite. Perovskite and nickeliferous pyrrhotite are also present.

The nodules can be classified mainly into two groups, micaceous dunites and glimmerites. In the dunite nodules, olivine is the major phase but phlogopite, magnetite, spinel and interstitial carbonate and glass are also present. Olivine, with rounded, resorbed or corroded outlines, forms a loose mosaic of relatively equidimensional grains and crystal outlines are enhanced by local magnetite coatings. The nature of the grain boundaries is probably a result of partial melting of original interstitial phases and selectively along olivine crystal phases. Although no major zoning patterns are recognised in the olivines, there is a tendency for iron enrichment and nickel depletion towards the rims of some. Core compositions vary from $Fo_{85.5}$ to $Fo_{88.4}$ in analysed samples, a 3% range comparable to that in the kimberlite megacrysts, although the overall composition is more comparable with the matrix olivines. Iron, calcium and aluminum contents are considerably higher in amounts than those found in most peridotite olivines. This suggests that the olivines have a cumulate rather than residual origin, and may be compared with olivines of the rare dunite nodules of Thaba Patsoa (Boyd and Nixon, 1975). The presence of the interstitial glass is direct evidence of the liquid phase produced by partial remelting of the cumulate dunite during mobilisation of the kimberlite. The glass is of dunitic composition, depleted in the alkalis and calcium. The deficiency of these elements is explicable by assuming fractional crystallisation of phlogopite, clinopyroxene and potassic richterites. The association of phlogopite with areas of partial melting is quite clear and although clinopyroxene and potassic richterite have not yet been identified in association with the glass phase, they both occur as xenocrysts and in nodules within the kimberlites. Devitrification of the glass phase involves the formation of richteritic amphiboles poor in potassium as would be expected from glass composition.

It is thought that the origin of the glimmerite nodule suite lies in the fractionation of phlogopite from a liquid produced by partial melting at depth in the mantle and subsequent incorporation as xenoliths in the ascending kimberlite. The chemistry of the glimmerite phlogopites suggests that the original partial melt liquid was rich in Mg, Fe, Ti, K, OH and CO_2 but low in SiO_2 and Cr_2O_3.

Kimberlite genesis presumably took place at depths in excess of 150 km. However, the presence of glimmerite nodules and matrix melilite suggests emplacement at depths from 10-100 cm.

TABLE 1

wt %	1	2	3
SiO_2	35.6	35.20	42.98
TiO_2	3.06	1.28	0.08
Al_2O_3	3.46	1.45	0.30
Fe_2O_3	4.60	0.95	as FeO 6.26
FeO	8.71	10.83	
MnO	0.20	0.20	0.18
MgO	27.90	36.50	38.99
CaO	6.78	2.58	0.02
Na_2O	0.82	0.40	nd
K_2O	2.00	0.80	nd
P_2O_5	0.40	0.14	nm
H_2O	3.72	insufficient sample	nm
CO_2	2.42	1.47	nm
TOTAL	99.67	91.80	

ppm	
Zr	307
Sr	726
Rb	72
Y	20
Ni	1149
Cu	73
Ga	10

1) Analysis of kimberlite dike, Saglek
2) Partial analysis of micaceous dunite nodule
3) Partial analysis of glass in nodule.

nd not detected
nm not measured.