CHEMICAL AND TEXTURAL VARIATIONS OF MICA IN THE NICKILA LAKE AND UPPER CANADA MINE KIMBERLITES, ONTARIO, CANADA

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Introduction

Micaceous kimberlites occur at Nickila Lake (NL) and the Upper Canada Mine (UCM) near Kirkland Lake in the Archean Abitibi greenstone belt, Superior province. K-Ar age determinations indicate the emplacement age of 151 Ma for the UCM kimberlite dyke (Lee and Lawrence, 1968) and that of 147 Ma for the NL kimberlite diatreme (Arima et al., 1986). Both kimberlites contain abundant phenocryst and xenocryst micas together with mica-bearing nodules. In this study we report various chemical and textural features of mica in the kimberlites.

UCM kimberlite

One of the striking features in this kimberlite is an occurrence of Ba-rich phlogopite in a pargasite-diopside-chromite nodule. The phlogopite is characterized by its high BaO, Na_2O, Cr_2O_3 and low TiO_2 contents (Table 1, Fig. 1-b). Relatively high Cr_2O_3 is also evident in coexisting pargasite and diopside (Table 1). Comparing to Ba-rich micas previously reported from mafic-ultramafic alkalic volcanic rocks (summarized by Gaspar and Wyllie, 1982; Barnett et al., 1984), the UCM Ba-phlogopite contains higher Cr_2O_3 and Na_2O. The pargasite is compositionally similar to amphibole of upper mantle origin (Dawson and Smith, 1982). Fine grained diopside neoblasts are present along the grain boundary of pargasite and phlogopite. Textural relations and chemistry of minerals suggest that the nodule is mantle origin. Phlogopite could be a principle carrier of BaO in the upper mantle.

In the UCM kimberlite, abundant mica phenocrysts typically exhibit dark brown core (up to 21 wt.% FeO_T) with a corroded outline (type 1 groundmass mica of Smith et al., 1978) which is mantled by euhedral to subhedral pale brown phlogopite. X-ray intensity distribution scan reveal the core and mantle domains of the mica have a chemically sharp and distinct interface. Mantle domain of the mica has composition similar to that of pale brown phenocryst phlogopite (type 2 mica of Smith et al., 1978) (Table 1, Fig. 1-b). In the type 1 micas, core domains of several different grains show a wide range of chemical variation especially in TiO_2 and FeO_T (Fig. 1-b). Type 2 micas exhibit a wide compositional range and most grains of the mica are uniform in composition, excepting some large grains in which Cr_2O_3 content decreases from core to margin with concomitant increases in FeO_T, TiO_2, and BaO, and decrease in MgO. Textural and chemical relations between mantle and core domains of the type 1 mica suggest a resorption of Fe-rich biotite xenocryst and overgrowth of type 2 mica prior to or during kimberlite emplacement. Additionally the sporadic occurrence of low TiO_2 phlogopite with reverse pleochroism (Table 1, Fig. 1-b) mantled by pale brown phlogopite compositionally identical to type 2 mica suggests micas of several different origins were introduced into the UCM kimberlite magma prior to or during the crystallization of type 2 phenocryst phlogopite.

NL kimberlite

The NL kimberlite is dominated by tuffisitic breccia facies containing a wide variety of incorporated nodules from the upper mantle and crust. Despite extensive alteration which oscured the original features of the kimberlite, the relatively fresh hypabyssal kimberlite fragment suggests that the diatreme is related to micaceous kimberlite magmatism. In the fragment, poikilitic phlogopite phenocrysts occur together with diopside, olivine, Mg-chromite and Mg-titanomagnetite spinels, calcite, apatite, perovskite, and serpentine. The phlogopite in the fragment contains higher BaO (up to 1.5 wt.%) and FeO_T than phlogopites in the tuffisitic facies (Table 1. Fig. 1-a). Ti-phlogopite also occurs in veinlet networks infiltrating a deformed ultramafic nodule incorporated in the fragment. The textural relations indicate that the deformation, transgranular fracturing, and neoblast formation of endiopside predate

Table 1. Analyses of minerals in the NL and UPC kimberlite

	1	2	3	4	5	6	7	8	9
SiO_2	39.72	45.76	52.53	-	36.22	38.55	42.20	41.47	41.75
TiO_2	0.00	0.02	0.11	0.13	3.06	3.22	0.11	3.04	2.19
Al_2O_3	15.01	10.95	3.32	12.89	16.32	13.77	10.19	9.17	11.76
Cr_2O_3	1.06	2.05	2.40	53.25	0.08	0.00	0.00	0.09	0.21
FeO_T	2.09	2.84	2.44	17.18	20.31	6.54	5.24	8.79	5.98
MnO	0.05	0.14	0.19	0.12	0.36	0.00	0.06	0.09	0.00
MgO	24.78	19.45	15.89	13.79	10.14	22.34	25.28	22.23	23.40
CaO	0.00	10.34	22.26	-	0.00	0.00	0.00	0.00	0.00
Na_2O	2.01	4.73	1.14	-	0.46	0.21	0.14	0.16	0.23
K_2O	6.79	0.06	0.04	-	10.09	10.58	10.07	10.07	10.12
BaO	4.27	0.16	0.01	-	0.23	0.31	0.20	0.39	0.00
Total	95.78	97.05	100.33	97.36	97.27	95.52	93.49	95.54	95.64

1-4; phlogopite, amphibole, clinopyroxene, and chromite in a Ba-phlogopite nodule incorporated in the UCM kimberlite respectively.
5-6; type 1 and type 2 mica in UCM kimberlite respectively.
7; reverse pleochroism phlogopite in UCM kimberlite.
8-9; phlogopite in hypabyssal fragment and in tuffisitic facies in NL kimberlite, respectively.

the veinlet formation. Veinlet phlogopites present along fractures of olivine and endiopside grains and connect with a kelyphite rim mantling a Cr-garnet. The kelyphite rim consists of Cr-rich phlogopite, Mg-Al spinel, and Cr-rich serpentine-like phase. The kelyphitic phlogopite is richer in Cr_2O_3 (2.5 wt.%) and Al_2O_3 (15 wt. %) than the veinlet phlogopite (0.75 wt.% Cr_2O_3 and 13.5 wt.% Al_2O_3) present in endiopside grains. The veinlet phlogopite associated with olivine has composition similar to groundmass mica of the host kimberlite fragment. The veinlet and kelyphitic phlogopites were probably formed simultaneously by the local scale equilibration during the infiltration of kimberlite liquid into the nodule.

Distinct variety of mica with comparable composition to type 1 mica (core domain) occurs in an salite-hornblende-apatite-ilmenite nodule in the NL kimberlite tuffisitic facies (Fig.1-b, B). Compositions of clinopyroxene, amphibole, and ilmenite in this nodule suggest that this nodule is a lower crustal origin. The mica shows relatively high Al_2O_3 (no tetrahedral site deficiency) and low Cr_2O_3 which are characteristics of type 1 mica , mica from alkali lamprophers (Rock, 1986), and mica of lower crustal metamorphic rocks. Although an igneous origin of type 1 mica derived from intrusive precusor to kimberlite has been suggested (Smith et al., 1978), type 1 mica could alternatively be of lower crustal metamorphic origin, incorporated into the kimberlite magma.

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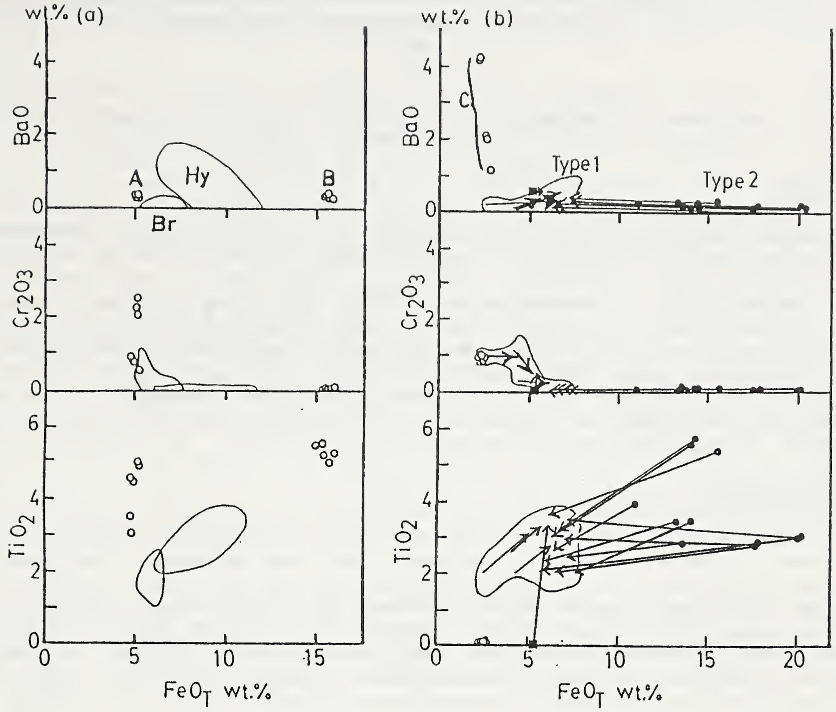

Fig. 1. Plots of BaO, Cr_2O_3, and TiO_2 against FeO_T for phlogopites from NL kimberlite (a) and UCM kimberlite (b). Solid circle = dark core of type 1 mica, solid squqre = reverse pleochroism phlogopite, open circle = mica from nodules; A = veinlet phlogopie nodule, B = apatite-amphibole-clinopyroxene nodule, C = Ba-phlogopite nodule. Hy and Br indicate phlogopite from hypabyssal fragment and tuffisitic facies respectively. Arrow indicates core-mantle or core-margin relations.