DISCRETE NODULES (MEGACRYSTS) AND LAMELLAR INTERGROWTHS IN FRANK SMITH KIMBERLITE PIPE

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The pipe is characterised by a wide variety of deep seated nodules. There are dunites (some with large opx porphyroclasts or relict gt and cpx) garnet lherzolites (some with 50% cpx), garnet pyroxenites grading with loss of opx, into eclogites, corundum eclogites, phlogopites, and gt pyroxenites with relict dunitic patches. The gt pyroxenite suite includes types with lamellar intergrowths of gt, cpx, opx ± chromite. The discrete nodules and megacrysts, to which this chemical study is mainly confined, include ilmenite, ilmenite-mica, ilmenite-cpx/opx (both as granular and lamellar intergrowths), garnet with inclusions of corundum or cpx, rare cpx, and opx with garnet inclusions. The mutual crystal intergrowth relationships within this group indicate consanguinity, but electron probe analyses show considerable variation (see table 1).

The discrete garnet nodules are typically, reddish-brown pyropes low in chromium (2381G, table 1; Nixon et al. 1963) with 0.8-1% TiO_2. However, a deep red nodule 2381F which is 5 cm across contains 3.36% Cr_2O_3 but nonetheless contains sufficient TiO_2 to differentiate it from the Cr pyropes of the granular ultrabasic nodules. A pale orange nodule (2381B, table 1) with kyanite inclusions is exceptionally aluminous and contains twice the normal amount of CaO (grossularite and is equated with the grospydite suite.

A diopside inclusion in a discrete pyrope nodule has apparently equilibrated at about 1300°C or higher (Ca/(Ca+Mg) = 33.7% and this is consistent with the small but perceptible amount of Ca solid solution in associated bronzite nodules (2381D and 2373, table 1). An omphacite nodule (38% jadeite), has a rather higher Cr_2O_3 content (2382, table 1) than most eclogites/griquaites, and may also belong to the discrete nodule suite.

The ilmenite nodules are charaterised by high geikielite and haematite contents with $<1\%$ Cr_2O_3. **Ilmenites are also intergrown in a** <u>granular</u> fashion with both bronzite (a fairly common association) and more rarely, diopside. The pyroxene Ca/(Ca+Mg) ratios show more limited solid solution between enstatite and diopside than those noted above and evidently equilibrated at shallower depth (cf. Boyd and Nixon, 1973).

The <u>lamellar</u> intergrowths comprise the familiar "ilmenite-diopside" "eutectic" graphic intergrowths and also nodules of alternating laminae of garnet, clinopyroxene and orthopyroxene. The ilmenites of the intergrowths and the discrete nodules show an inverse relationship between geikielite and haematite contents. Compared with Monastery Mine and northern Lesotho occurrences the Frank Smith ilmenites appear to be enriched in MgO (figure 1) although zoned reaction mantles can produce wide variations even within a single grain (Haggerty, 1973). In 2353C there are fine exsolution zones similar to magnetite (magnesioferrite) - ulvöspinel phases that we have noted at Monastery Mine.

The clinopyroxenes which coexist with the ilmenites also appear to be enriched in MgO compared with many nodules from elsewhere.

The silicate lamellar intergrowths are commonly associated with garnet pyroxenite and these appear to be mobilised phases since they are often sharply demarcated in the same hard specimen from associated (?residual) dunitic patches. The intergrowths are therefore regarded as quenched products of a garnet pyroxenite melt. An immediate ultrabasic mantle parentage is attested by the high Cr content of the pyrope and diopside, but the latter appears to have equilibrated at similar temperatures to the granular intergrowth of ilmenite and clinopyroxene (table 1).

The existence of differentiated garnet pyroxenites and heterogeneous ilmenite-pyroxene mixtures of intermediate depth (i.e. above the mantle low velocity zone of intense shearing and discrete nodule formation - Boyd and Nixon 1973) is paralleled at Matsoku. Here, the ultrabasic nodules have also suffered sulphide metasomatism and deformation, producing gneissose textures (Cox et al. 1973).

These "Matsoku effects" of folding and minor shearing, ilmenite enrichment, metasomatism, melting and recrystallisation, are equated with the upward migration of volatile and mobile constituents, including potassium, through the sheared asthenosphere. The mobile constituents are envisaged as being kneaded out in the manner described by Weertman (1972) and providing lubrication at the base of the African plate (lithosphere) for the dispersal of Gondwanaland.

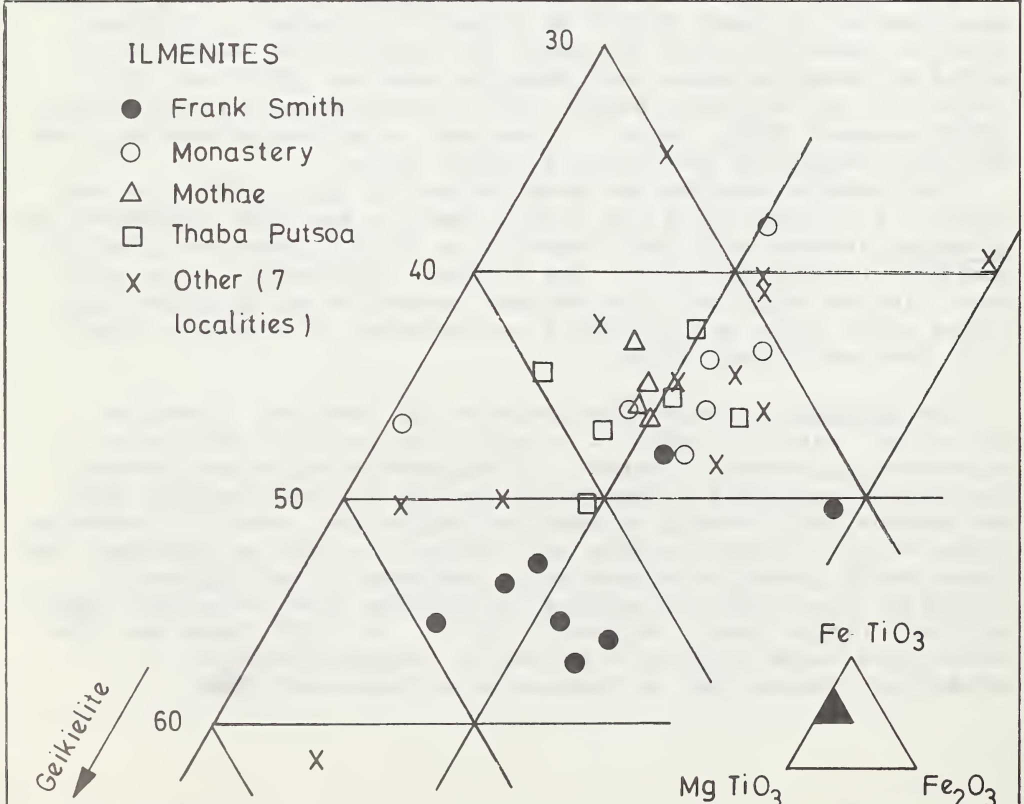

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Figure I

Figure I. Compositions of ilmenites from Frank Smith and other kimberlites.

References

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TABLE I ANALYSES OF MINERALS FROM FRANK SMITH KIMBERLITE PIPE

DISCRETE NODULES

PHN	2381G	2381B	2381F	2381D	2381D	2382	2373	2373	2353C	2353E
	gt	gt	gt	gt	cpx incl	cpx	opx	gt incl	il	il
SiO_2	41.88	40.75	42.27	41.46	54.84	54.43	56.16	41.79	0.10	0.10
TiO_2	0.86	0.13	0.94	0.72	0.32	0.68	0.21	0.89	49.41	43.67
Al_2O_3	21.83	23.27	19.64	20.85	3.60	7.20	1.01	21.36	1.75	0.35
Cr_2O_3	0.03	0.10	3.36	1.85	0.90	1.29	0.07	0.85	0.72	0.93
Fe_2O_3	—	—	—	—	—	—	—	—	13.94	20.17
FeO	11.37	9.68	7.26	8.33	4.79	4.57	7.64	9.72	21.54	23.81
MnO	0.41	0.29	0.29	0.26	0.13	0.09	0.16	0.30	0.24	0.27
NiO	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.15	0.15
MgO	19.13	15.58	21.05	21.59	18.88	13.30	32.55	20.93	12.66	8.49
CaO	4.46	9.86	5.16	4.22	13.33	11.48	1.19	3.99	0.04	0.02
Na_2O	0.07	0.08	0.03	0.09	2.58	5.36	0.24	0.09	n.d.	n.d.
Totals	100.04	99.74	100.00	99.37	99.37	98.40	99.23	99.92	100.55	97.96
Ca/(Ca+Mg)%					33.7	38.3	2.6			

continued on next page.

Table I (continued) GRANULAR INTERGROWTHS

PHN	2349		235IA		235IB		2354	
	il	cpx	il	opx	il	opx	il	opx
SiO_2	0.10	53.41	0.13	55.64	0.09	56.43	0.12	56.82
TiO_2	49.36	0.35	52.85	0.29	54.08	0.22	52.15	0.29
Al_2O_3	0.59	2.39	0.54	0.92	0.70	1.24	0.49	0.95
Cr_2O_3	0.77	0.32	0.71	0.06	1.18	0.10	0.43	0.02
Fe_2O_3	12.47	—	9.19	—	7.21	—	10.04	—
FeO	25.86	4.77	23.76	7.52	22.93	8.28	24.11	7.68
MnO	0.24	0.11	0.20	0.16	0.25	0.14	0.23	0.16
NiO	0.13	n.d.	0.21	n.d.	0.20	n.d.	0.21	n.d.
MgO	10.24	16.82	13.16	33.63	14.21	32.80	12.59	33.77
CaO	0.02	18.90	0.04	1.08	0.02	0.79	0.04	1.09
Na_2O	n.d.	1.84	n.d.	0.21	n.d.	0.29	n.d.	0.27
Totals	99.78	98.91	100.79	99.51	100.87	100.29	100.41	101.05
Ca/(Ca+Mg)%		44.7		2.3		I.7		2.3

LAMELLAR INTERGROWTHS

PHN	2348A		2348B		2367			
	il	cpx	il	cpx	gt	cpx	opx	chr*
SiO_2	0.11	54.01	0.11	54.58	40.64	54.32	57.87	1.65
TiO_2	49.96	0.50	48.27	0.42	0.31	0.13	0.05	3.55
Al_2O_3	0.91	2.29	0.75	2.30	16.60	1.93	0.55	7.62
Cr_2O_3	0.74	0.18	0.07	0.01	7.88	2.92	0.39	44.63
Fe_2O_3	12.25	—	14.80	—	—	—	—	7.96
FeO	22.37	4.80	21.73	4.96	7.92	2.48	5.23	22.79
MnO	0.23	0.14	0.24	0.14	0.54	0.14	0.15	0.64
NiO	0.23	n.d.	0.15	n.d.	n.d.	n.d.	n.d.	0.20
MgO	12.45	18.51	12.00	18.22	18.60	16.35	35.30	9.38
CaO	0.03	16.44	0.02	17.49	6.36	18.12	0.42	0.02
Na_2O	n.d.	2.11	n.d.	2.21	0.05	3.18	0.12	n.d.
Totals	99.28	98.98	98.14	100.33	98.90	99.57	100.08	98.44
Ca/(Ca+Mg)%	39.0			40.8		44.3	0.8	

*secondary chromite octahedra in phlogopite.

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