THE KIMBERLITES OF GUINEA, WEST AFRICA

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The most extensive field of kimberlites in West Africa occurs in south-central Guinea, but in spite of their discovery in 1952 by Soguinex and later considerable work by Russian geologists in the 1960's (Vladimirov et al., 1971) little information is available in the scientific literature. About 20 small kimberlite pipes and numerous dikes have been emplaced into Archaean basement rocks consisting mostly of granitic gneisses and quartzitic schists, possibly of Dahomeyan or Birrimian age. Extensive dolerite magmatism occurred about 180 Ma ago and this predates the kimberlitic events. The kimberlite dikes are often oriented almost E-W, but other trends such as 055° and 115° are present. Dikes vary in width from thin stringers or veins (cms), to proper dikes 3 m thick. Dikes may occur "en echelon" or in groups of 3 or more, and extend for 2-3 km. The pipes are relatively small, resembling more the "blows" of South Africa. The largest pipe, Antochka, is roughly 5.2 ha in size. In some instances numerous veins and stringers are localized and form kimberlite stockworks. Clusters of pipes occur, for example at Banankoro, and often it appears that pipes have originated at the intersection of dikes. The absolute age of the kimberlitic magmatism is unknown, but is younger than the 180 Ma age of the dolerites which are often cross-cut by the kimberlite dikes. The kimberlites have undergone erosion since emplacement and probably represent root zone facies.

Unfortunately, many of the pipes, dikes and associated alluvial deposits have been ravaged by the local miners. This together with the thinness of many dikes, the extensive and deep weathering makes sampling at present difficult. Nevertheless, samples from the Antochka and Droujba pipes have been examined as well as heavy mineral concentrate immediately above or close to other pipes and dikes. Kozlov (1966) reports that most dikes consist of an olivine macrocryst-bearing kimberlite sometimes rich in groundmass-mica, whereas the pipes are formed from brecciated kimberlite. The minerals in both types of kimberlite appear to be similar, but differ in modal percentage. Koslov comments that clinopyroxene is present in the kimberlite groundmass of both dikes and pipes, but this mineral was not identified in the present study.

The Droujba kimberlite consists of large (0.5 cm) macrocrysts of olivine, ilmenite and rare pyrope garnet (<1.2 cm) set in a fine grained groundmass of phlogopite, spinel, calcite, serpentine and minor perovskite and some sulfides. Small euhedral (0.5 mm) olivines are scattered throughout the groundmass. The Antochka kimberlite is somewhat similar although mica appears to be smaller and less abundant. Autoliths were observed in one pipe as well as xenoliths of granulite, presumably derived from the lower crust. It is reported that all the kimberlites contain diamond, but the dikes appear to be richer in this mineral than the pipes. Ilmenite is the most abundant and characteristic tracer mineral in the Guinean kimberlites and may form megacrysts up to 3 cms in size.

Phlogopite in the Droujba kimberlites occurs in three distinct ways: 1) as light brownish microphenocrysts (TiO_2 2-4 wt.%; Al_2O_3 14-17 wt.% and FeO_T 5-7.5 wt.%) with colorless rims (TiO_2 < 1 wt.%; Al_2O_3 10-14 wt.% and FeO_T 2-5 wt.%), 2) as laths with colorless cores similar in compositional range to the brownish microphenocrysts, but having orange rims of tetraferriphlogopite (TiO_2 and Al_2O_3 < 1 wt.%, FeO_T 12-18 wt.%), and 3) as small groundmass micas with high Al_2O_3 contents of between 16 and 19 wt.%, TiO_2 < 2.5 wt.% and FeO_T 3 to 5.5 wt.% (Table 1). No zoning was observed in the groundmass micas. Cr_2O_3 contents are low (<0.2 wt.%) in all micas although the cores of the brown and colorless microphenocrysts appear on average to be higher than the rims. In general the micas do not contain inclusions of spinel suggesting much of the groundmass mica crystallized later than the spinel and ilmenite, a feature which may explain the low TiO_2 content of the phlogopite. Phlogopites similar to the brownish and colorless microphenocrysts have been noted in chlorite-phlogopite intergrowths from Koidu, Sierra Leone by Tompkins and Haggerty (1984); however, compositionally the core and rims are reversed. Phlogopite in the Antochka kimberlite is fairly uniform in composition (TiO_2 2-3 wt.%, Al_2O_3 11.5-14.5 wt.% and FeO_T 5.5-7 wt.%) (Table 1) and appears to be similar to Type-II groundmass micas of Smith et al. (1978).

Spinels are common in both the Droujba and Antochka kimberlites and are generally < 0.25 mm in size. Most are euhedral to subhedral, but those larger than 0.1 mm are usually embayed or corroded. Atoll spinels are common in Droujba, but are absent in Antochka. Compositionally the spinels range from aluminous magnesian chromites (Cr_2O_3 >48 wt.%, Al_2O_3 3-15 wt.% and MgO 12-15 wt.%) to titanian chromites (TiO_2 6-12 wt.%) to ulvospinel-magnetite (Table 2). This trend (AMC-TMC-Usp Mag) has been observed also in spinels from kimberlites at Bellsbank (Boctor and Boyd, 1982), Zagadochnaya (Rozova et al., 1982) and Koidu (Tompkins and Haggerty, 1984) and corresponds to Trend 2 of Mitchell (1986).

The least evolved and rarest of the spinels at Droujba is a translucent red aluminous magnesian chromite (TiO_2 < 1 wt.%) which is zoned towards an opaque rim containing less Al_2O_3 and Cr_2O_3 and more TiO_2 than the red core (Table 2). The most evolved spinels in the Droujba kimberlite are the groundmass and outer mantles of the atoll spinels, these are mostly ulvospinel-magnetite with up to 1.5 wt.% MnO. The atoll cores are generally titanian magnesian chromites and form the intermediate section of Trend 2. The cores show variation in mg (0.2-0.5) and depletion in Al and Cr as Ti increases. In contrast to Droujba, the Antochka kimberlite contains an abundance of the translucent red-brown least evolved AMC spinels. These, similar to those in the Droujba kimberlite are mantled by opaque rims consisting of the more highly evolved ulvospinel-magnetite members (Table 2).

Olivine ($\sim Fo_{90}$) from the Droujba pipe is typically kimberlitic as is the garnet (Cr_2O_3 $\sim$2 wt.%; CaO $\sim$4 wt.%; MgO 22-23 wt.%). As far as is known no group 10 garnets (Dawson and Stephens, 1975) have been reported to date from Guinea.

Ilmenite, the most ubiquitous mineral in Guinean kimberlites has varying MgO contents from 8 to 20 wt.%, and Cr_2O_3 0.3-1.6 wt.%. In the Droujba kimberlite groundmass ilmenites have slightly lower Cr_2O_3 and higher MnO contents than macrocrysts (Table 3).

There is a similarity between the occurrences of kimberlite in Guinea and those in Sierra Leone (Granthan and Allen, 1960; Tompkins and Haggerty, 1984) and Liberia (Haggerty, 1982). In the three regions dikes seem to predominate over pipes, which are all relatively small. There are also petrographic and mineralogical similarities between the kimberlites of Guinea and Sierra Leone in that they consist predominantly of macrocrystal olivine and ilmenite in a groundmass of small second generation olivine, phlogpite, serpentine and calcite. The minerals also are comparable in their chemistries. The third major kimberlite field in West Africa, that of Mali, close to Guinea, appears to be somewhat different in that pipes seem to be much more common than dikes.

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Table 1: Representative analyses of Phlogopite, Olivine and Garnet.

	Mica						Olivine		Garnet		
	1	2	3	4	5	6	7	8	9	10	11
SiO_2	38.1	38.8	38.3	38.1	40.1	39.3	40.6	40.6	43.2	44.0	42.6
TiO_2	3.01	0.49	1.08	3.36	0.26	2.42	0.04	0.02	0.69	0.34	0.48
Al_2O_3	15.2	13.5	17.2	15.8	0.92	13.7	0.00	0.00	19.9	21.3	20.2
Cr_2O_3	0.01	0.02	0.07	0.02	0.00	0.7	0.04	0.00	2.18	0.83	3.56
FeO^*	6.48	4.87	3.75	5.60	15.7	6.72	11.6	7.35	8.11	7.62	7.52
MgO	21.0	27.8	24.6	22.9	26.7	23.0	47.9	51.1	22.7	21.3	21.9
CaO	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.04	4.37	4.12	4.36
MnO	0.06	0.00	0.09	0.11	0.07	0.14	0.19	0.07	0.24	0.38	0.30
NiO	0.11	0.06	0.03	0.08	0.01	0.03	0.28	0.42	0.00	0.00	n.d.
Na_2O	0.02	0.00	0.39	0.00	0.02	0.36	0.09	0.04	0.06	0.12	n.d.
K_2O	10.0	8.34	10.1	10.6	9.95	9.32	0.00	0.01	0.00	0.00	n.d.
	94.0	93.9	95.6	96.6	93.7	95.1	100.8	99.6	101.4	99.6	100.9

* All iron expressed as FeO. 1-5,7-10 Droujba; 6 Antochka; 11 Bafateya;
1 and 2 - core and rim microphenocryst, 3 - groundmass, 4 and 5 - core and rim (tetraferriphlogopite).

Table 2: Representative analyses of spinels in Guinean kimberlites.

	1	2	3	4	5	6	7	8	9	10
TiO_2	7.83	8.08	5.41	6.36	3.65	1.10	7.26	2.81	2.04	2.93
Al_2O_3	0.43	5.94	1.98	4.80	1.15	3.35	1.49	0.02	9.47	0.92
Cr_2O_3	2.94	15.3	2.25	44.4	1.13	62.7	0.95	1.92	54.1	0.66
FeO_T	74.7	54.6	72.2	29.2	77.6	18.8	78.0	87.0	20.0	72.0
MgO	6.18	13.7	11.3	14.7	10.8	12.8	6.05	2.57	15.0	16.5
CaO	0.15	0.13	0.09	0.02	0.04	0.00	0.79	0.33	0.12	0.46
MnO	1.93	0.74	1.32	0.84	1.01	0.24	1.43	0.92	0.34	1.18
	94.2	98.5	94.6	100.3	95.4	99.0	96.0	95.6	101.0	94.7
$Fe_2O_3^*$	52.5	40.0	60.2	-	66.7	-	56.8	64.4	-	71.8
FeO^*	27.5	18.6	18.1	-	17.6	-	26.9	29.0	-	7.32
	99.5	101.5	100.7	-	102.8	-	101.7	102.0	-	101.8

FeO_T All iron as FeO; * Based on 4 oxygen and 3 cations.
1-7 Droujba; 8-10 Antochka
1,2 - groundmass; 3 - mantle on ilmenite; 4,5 - core and rim of atoll;
6,7 - core and rim of red aluminous magnesian chromite; 8 - groundmass
9,10 - core and rim of red aluminous magnesian chromite

Table 3: Representative analyses of ilmenites.

	1	2	3	4	5	6	7	8	9	10
TiO_2	49.7	51.5	59.5	58.4	51.5	53.5	50.3	49.3	50.9	49.4
Al_2O_3	1.29	0.73	0.05	0.14	0.63	0.79	0.63	0.64	0.53	0.50
Cr_2O_3	0.56	0.66	0.39	0.25	1.57	0.77	0.68	0.41	0.71	0.30
FeO_T	36.0	25.3	20.8	22.9	33.7	29.1	38.3	39.3	35.3	39.5
MgO	12.5	20.5	17.6	15.7	11.6	14.6	10.1	9.62	11.2	9.75
CaO	0.05	0.02	0.08	0.06	0.03	0.05	0.02	0.02	0.02	0.01
MnO	0.25	0.83	1.71	1.55	0.21	0.33	0.18	0.20	0.23	0.30
	100.4	99.5	100.1	99.0	99.3	99.1	100.2	99.5	98.9	99.8

1-4 Droujba; 5,6 - Fenaria dike; 7,8 - Banankoro pipes 3 and 4;
9,10 Bafateya dike. All megacrysts except 3 and 4 which are groundmass phases.