SILICATE-BEARING DIAMONDITES

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As of the date of writing this report, we have studied in detail 42 diamondites from an unknown but likely Southern African source (samples are similar to what has been described by Gurney and Boyd, 1982, and Kirkley et al., 1991). Some data are already published (Kurat et al., 1999; Kurat and Dobosi, 2000; Dobosi and Kurat, 2002; Maruoka et al., 2004). Here we summarize the published data and those acquired over the last two years. The new data forced a revision of the classification scheme and greatly extended the existing database that allowed us to also gain additional insight into diamondite genesis and present a refined model here.

Diamondites are polycrystalline diamond rocks with grain sizes ranging from about 50 μm to >1 mm and some variation of the grain-size within most samples. Their masses range from 5 to 60 ct and their sizes from ~1 to 2.5 cm. Diamondites occasionally contain also minor silicates, oxides and sulfides. Not present are in diamondites the most common mineral of the upper mantle, olivine, as well as orthopyroxene and omphacite. Among the silicates, garnet dominates as it is present in all silicate-bearing diamondites encountered so far. According to the color of the garnet (hence, its chemical composition) we distinguish "peridotitic" and "eclogitic" populations, similar to what has been described from silicate inclusions in single crystal diamonds (e.g., Bulanova, 1995). In this study we distinguish between 5 garnet types that are present in diamondites: violet or lilac Peridotitic (P) and Transitional (T), orange Eclogitic 1 (E1), orange Eclogitic 2 (E2) and brownish Eclogitic 3 (E3). Examples of the chemical composition of these types are given in the Table. It is evident, that the Cr-content – and to a lesser degree the Fe content – governs the color. All P garnets have a "lherzolitic" composition as defined by Sobolev (1977), except one that is "harzburgitic". Note that garnets of types P, T and E1 have very much the same Fe content and Mg/Fe ratio (which corresponds to that of upper mantle peridotites). Types E2 have slightly and type E3 strongly enriched Fe contents. With increasing Fe content the atomic Fe/Mn ratio also increases from (on average) 23 to 45. Of the 42 garnets, 13 belong to P, 7 to T, 6 to E1, 9 to E2 and 7 to E3.

Green clinopyroxenes are associated with 3 P and 1 T garnet only. They occur isolated or intergrown with garnet (in some cases the texture resembles exsolution from the garnet) and have a low but detectable K content. Clinopyroxenes appear to be in chemical equilibrium with the co-existing garnet.

Trace element contents of silicates were determined by LA-ICP-MS. Trace element abundances and chondrite-normalized abundance patterns are complex and roughly correlated with major and minor element composition. As recognized before (Kurat and Dobosi, 2000; Dobosi and Kurat, 2002), abundances of HFSEs in garnets indicate formation of diamondites and their associated silicates from carbonate-bearing fluids/melts. This finding is strongly supported by recent C isotope analyses of diamondites (Maruoka et al., 2004). These data show that most diamondites have light C and their degree of depletion in ^{13}C is independent of the chemical composition of the silicates, i.e., diamondites containing P or E garnets have indistinguishable C isotope compositions. The data also indicate that isotope fractionation between elemental C and carbonates is likely the cause of the ^{13}C deficits in diamondites rather than crustal contamination. In addition, the abundant presence of carbonatitic fluid inclusions in diamonds and silicates of diamondites (Kurat and Dobosi, 2000), which are very rich in incompatible elements, supports such an origin as do recent experiments that demonstrate an astonishing ease to grow diamonds and diamondites from carbonatitic melts (e.g., Litvin and Zharikov, 2000; Bobrov et al., 2002; Pal'yanov, 2002; Litvin and Spivak, 2003; Litvin et al., this volume).

The previously unsolved problem of the formation of Cr-rich and Cr-poor garnets from apparently peridotitic environments (e.g., Dobosi and Kurat, 2002) can be solved now. There is a clear positive correlation between the abundances of Cr and some highly incompatible HFSEs in garnets (e.g., Nb, U, Zr, Hf) giving support to the view that low degree of partial melting creates the Cr-rich fluids to form the Cr-rich garnets. Chromium behaves only slightly incompatibly in peridotite-silicate liquid systems (e.g., Kurat et al., 1980) but apparently becomes strongly incompatible in peridotite-carbonatite liquid systems. This also solves the mass balance problem created by the harzburgite-source-theory for Cr-rich garnets.

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Table: Examples of garnet compositions identified in diamondites (in wt.%)

	"Peridotitic"		"Eclogitic"		
	P	Trans.	E1	E2	E3
	Dia 005	Dia 006	Dia 001	Dia 002	Dia 020
SiO_2	41.69	43.26	42.70	41.80	41.37
TiO_2	0.14	0.56	0.64	0.40	0.24
Al_2O_3	17.90	21.71	22.60	22.80	23.03
Cr_2O_3	7.18	1.87	0.73	0.25	0.05
FeO	7.10	6.96	7.40	9.60	17.40
MnO	0.36	0.28	0.29	0.32	0.40
MgO	19.71	22.31	21.80	19.00	14.38
CaO	5.70	3.86	3.80	4.60	4.68
Na_2O	0.02	0.09	0.11	0.07	0.08
Total	99.81	100.89	100.07	98.84	101.63
	Chemical formulae				
Si	3.023	3.027	3.009	3.014	3.004
Ti	0.008	0.029	0.034	0.022	0.013
Al	1.530	1.791	1.878	1.938	1.971
Cr	0.412	0.104	0.041	0.014	0.003
Fe_{tot}	0.430	0.406	0.435	0.578	1.054
Mn	0.022	0.017	0.017	0.020	0.025
Mg	2.129	2.326	2.289	2.041	1.556
Ca	0.443	0.289	0.287	0.355	0.364
Na	0.003	0.012	0.015	0.010	0.011
Total cations	8.000	8.002	8.005	7.992	8.001
Mg/(Mg+Fe)	0.83	0.85	0.84	0.78	0.60
Fe/Mn	19.4	24.5	25.1	29.5	42.8
Av. Fe/Mn (N)	23.1 (13)	23.4 (7)	24.4 (6)	28.6 (9)	45.0 (7)

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