XENOLITHS OF DIAMONDIFEROUS PERIDOTITES FROM UDACHNAYA KIMBERLITE PIPE, YAKUTIA

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The data obtained recently estimate the diamond age as 3.2-3.4 b.y. (Richardson et al., 1984) as compared with ages of diamondiferous kimberlites ranging from 20 to 1200 m.y., which directly indicates the xenogeneity of diamonds in kimberlites, and therefore the study of xenoliths of diamondiferous rocks is especially important.

Results of a study of xenoliths of diamondiferous peridotites (XDP) from the Udachnaya kimberlite pipe are given in this work. Our XDP collection from the Udachnaya pipe amounts to 18 specimens, i.e. more than a half of the total number of the findings of this type known at present (Sobolev et al., 1984). Sixteen xenoliths are composed of extremely depleted megacrystalline rocks where an olivine fraction accounts for more than 95% of volume. Six xenoliths are represented by paragenesis of olivine and pyrope; other six - by that of olivine, pyrope and chromite; three specimens are represented by paragenesis of olivine, pyrope, enstatite and chromite and one - by that of olivine, enstatite and chromite. One xenolith is composed of granular rock with deformation traces, it belongs to the paragenesis of ilmenite-pyrope lherzolite. And the last xenolith is composed of a rock the texture of which is intermediate between megacrystalline and granular rocks and refers to the paragenesis of pyrope harzburgite. Fresh olivine and enstatite are present in 17 and 2 specimens, respectively. A number of the diamond crystals found in XDP from the Udachnaya pipe varies from 1 to 7, their sizes being from 0.2 to 3 mm. The diamonds are practically colourless in all specimens. The predominant form of diamonds is octahedral and the presence of trigonal growth layers is typical of them.

The main results of the XDP mineral composition investigation by the microprobe analysis are given in Table. It shows that olivines from megacrystalline XDP are characterized by a rather low iron content, a stable chromium impurity, a negligible impurity of CaO, an average content of NiO being 0.36 wt% in a range of 0.31 to 0.39. The olivine from xenolith of diamondiferous ilmenite-pyrope lherzolite is characterized by higher values of iron content, chromium and calcium impurities. Pyropes in megacrystalline XDP are poor in iron and calcium and rich in chromium, which along with the extremely low content of titanium allows these to be clearly distinguished from pyropes of xenoliths of sheared lherzolites (Sobolev et al., 1984) and to be practically identified with pyropes included in diamonds of a similar paragenesis from the Udachnaya pipe. Chromites have very high contents of Cr_2O_3 and low, as compared with chromites from kimberlite concentrates, contents of titanium as well as magnetic component. Two enstatites studied from diamodiferous xenoliths of pyrope harzburgite and ilmenite pyrope lherzolite have marked differences in contents of TiO_2 (0.03 and 0.12 wt%), CaO (0.22 and 0.86 wt%), Na_2O (0.13 and 0.30 wt%) as well as iron content (Fe/Fe + Mg = 5.9 and 7.7%), which reflects the nature of their parageneses very well.

The comparative analysis of the results of the study of XDP minerals and the inclusion minerals of the same name in diamonds of a similar paragenesis from the Udachnaya pipe shows their similarity in compositions (see Table). This confirms the hypothesis that diamonds came into kimberlite in consequence of disintegration of ancient diamondiferous peridotites of the upper mantle (Boyd, Finnerty, 1980; Sobolev et al., 1984; Richardson et al., 1984; Haggerty, 1986). At the same time, there are

Table

		olivine			pyrope			chromite	
		1(15)	2(61)	3	1(15)	2(89)	3	1(10)	2(87)
f	$\bar{x}$	6.99	6.97	8.8	14.9	14.2	16.4	47.6	40.7
	min	6.22	5.03		12.5	12.3		45.0	30.4
	max	8.11	8.12		16.1	16.5		51.0	55.3
Cr_2O_3	$\bar{x}$	0.04		0.06	10.4	9.88	5.99	63.8	65.2
	min	0.02			7.1	4.93		61.7	61.9
	max	0.05			12.7	15.6		65.4	68.9
CaO	$\bar{x}$	0.007		0.042	2.38	2.67	5.41		
	min	0.003			0.88	0.68			
	max	0.011			4.99	6.54			
TiO_2	$\bar{x}$				0.06	0.08	1.91	0.15	0.15
	min				0.02	0.01		0.02	0.01
	max				0.14	0.79		0.50	0.79
Al_2O_3	$\bar{x}$							4.80	5.41
	min							3.60	1.58
	max							5.79	8.81

Notes: 1 - XDP of harzburgite-dunite paragenesis; 2 - inclusions in diamonds of harzburgite-dunite paragenesis of the Udachnaya pipe; 3 - xenolith of diamondiferous ilmenite-pyrope lherzolite, a number of the grains analyzed is given in parentheses.

evidences that diamondiferous rocks have undergone some evolution of parameters of equilibrium after the diamond formation. In particular, the high-temperature character of equilibrium of olivine-garnet associations found in diamonds from the Udachnaya pipe is observed steadily to be higher than equilibrium temperatures of analogous pairs in XDP from the same pipe ($\bar{x}$ = 1010 °C and 920 °C, respectively) (Sobolev et al., 1984). In a series of XDP from the Udachnaya pipe related to harzburgite paragenesis, regular chromite-enstatite intergrowths were found which are spatially consistent with garnet extractions, this being interpreted as reaction disintegration resulted from the decompression of a certain part of knorringite molecule according to the scheme:
$MgCr_2Si_3O_{12} + Mg_2SiO_4 \longrightarrow 4\ MgSiO_3 + MgCr_2O_4$ (Pokhilenko et al., 1977).

The facts observed, along with some others, may be explained by two reasons: 1) changes in thermal mode in different areas of the platform mantle within the period between the diamond formation and the time of diamond capture by kimberlite; 2) dynamical processes including significant displacements of mantle substance in vertical direction in kimberlite generation zones during and after diamond formation (Sobolev et al., 1984; Haggerty, 1986). To our opinion, these reasons, along with the fluid mode, determine the appearance of blocks of cold diamondiferous peridotites in central regions of cratons at relatively small depths, possibly, essentially higher than the level of diamond-graphite phase transition, their xenoliths being also found in the Udachnaya pipe.

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