COMPOSITION AND THERMAL STRUCTURE OF THE MANTLE IN PERIPHERAL PARTS OF SIBERIAN CRATON

IGOR VICTOROVICH ASHCHEPKOV¹, NIKOLAY VASILIEVICH VLADYKIN², ANATOLIY ILIYCH SAPRYKIN¹, OLGA STEPANOVNA KHMELNIKOVA¹ & GENADIY NIKITOVICH ANOSHIN¹

ABSTRACT The deep seated minerals from Mesozoic kimberlite and lamproite rocks from two peripheral parts of Siberian craton - Chompolo area in Aldan shield and East Priyanabarie and reconstructed mantle sections are compared. Despite the difference in mineral assemblages, the mineral chemistry suggests essential interaction with PT plume melts. Mantle column beneath Aldan is heated and depleted to Fe- harzburgites while the middle part of the section near 35-40 kbar is constructed from garnet- clinopyroxenites. In Priyanabarie essential part of mantle column starting from 65 kbar is changed to coarse dunites with nests of garnet pyroxenites and abundant lenses of glimmerites and ilmenite orthopyroxenites, cold eclogites and irregularly heated pyroxenites are referred to the pressures 40-50 kbars. Medium-grained serpentinized pyroxenites comprise the uppermost mantle there.

Keywords: kimberlite, ilmenite, pyropes, spinels, Aldan, Anabar, mantle

INTRODUCTION The peripheral regions of cratons and ancient shields are of great interest for the prospecting of diamonds and diamond-bearing rocks. Most of lamproitic localities and many micaceous kimberlites were discovered in those regions, for example diamond deposits in NW Australia (Jakes, 1998) and Arkhangelsk kimberlites (Sablukov *et al.* 2000, Beard *et al.* 2000), etc. These areas are characterized by relatively depleted compositions of the deep mantle roots and micaceous metasomatism generated favorable sources for high potassium undersaturated magmas (Foley *et al.* 2000). As a rule, the diatremes in peripheral parts of cratons are smaller but sometimes more productive. Here, we compare preliminary data for some marginal areas of Siberian platform - Priyanabarie (NE part of Anabar shield) and Chompolo region (NW of Aldan shield) which are situated at the ages of the ancient shields.

LOCATION Chompolo Area In the upper stretches of Amga river was discovered (Shilina *et al.*, 1959) a group of lamproitic and kimberlitic diatremes and dykes located within the field ~ 20 km in diameter (Kornilova 1997) (Fig.1). The rocks are represented by breccias highly contaminated with gneisses, crystalline schists and mantle xenoliths. Originally the magmas forming the diatremes were kimberlitic and lamproitic in composition and erupted most likely in the Triassic. The pyropes from these pipes are common in Jurassic sandstones.

Priyanabarie A dense net of the Early Mesozoic micaceous kimberlites, melilitites, alnoites and rare carbonatites is located in 300x70 Km zone rimming the Anabar shield from the east (a few pipes locate directly in the shield). Several separate kimberlitic fields along the NW Anabar shield margin contain tens of 'anomalies' sometimes compiling the strengthened

Figure 1 - Scheme of the Siberian platform and location of kimberlitic fields. 1 - Siberian platform; 2 - Shields; 3 - Kimberlitic fields; 4 - Studied areas.

zones parallel to Anabar river tributaries (Fig.1).

MANTLE INCLUSIONS Chompolo Area Mantle inclusions are represented by completely disintegrated mantle xenoliths with fresh grains of pyroxenes, pyrope or almandine-pyrope garnets, Cr-spinels, phlogopites and rare olivines. No megacrystic inclusions except for abundant Ti-bearing mica were discovered.

¹ United Institute of Geology Geophysics and Mineralogy, SD RAS, 630090 Novosibirsk, ac.V.A.Koptyug ave.3, garnet@uiggm.nsc.ru

² Institute of the Geochemistry, SD RAS, 664033 Favorskii str.1a, vlad@igc.irk.ru

Prianabarie Mantle xenoliths are represented by partly or completely serpentinized harzburgites and dunites, abundant glimmerite veins and Ilm-Opx bearing cumulates, rarer Gacclinopyroxenites and a few lherzolites. Rarely xenoliths contain pyropes. Pyroxenites are scarce but glimmerites, often forming veins in dunites, are frequent. The megacryst association is restricted by mica and abundant ilmenites occurring in most kimberlites and related rock types.

MINERAL CHEMISTRY Pyropes in the Chompolo area form three groups in the Cr_2O_3 -CaO diagram: a) correspondent to pyroxenites in 0-2% Cr_2O_3 interval, b) to lherzolites in 2-5% Cr_2O_3 and c) joint rise to garnet wehrlite fields similar to those found for Jericho pipe (Kopylova et al., 1999) (Fig. 2a) (Tables 1-2).

In Prianabarie the following groups were distinguished: a) 1-3% Cr_2O_3 corresponding to pyroxenites; b) 3-6% Cr_2O_3 (up to 10% for Dyukon field) to lherzolites and c) more Cr-rich subcalcic pyropes with 6.5% Cr_2O_3 for Istok field and 11% for Dyukon field came from dunites-harzburgites (Fig.2c) (Table

3). The compositions analyzed in concentrate from anomaly 17/63 coincide with most Cr- rich pyropes found in xenoliths. The break between 6.5 and 9.5% Cr_2O_3 may mean the layering and garnet-less depleted mineralogy.

Diopsides in Chompolo field are moderately depleted, the most common type contain nearly equal amounts of Na_2O , Cr_2O_3 , FeO ~1-5-2.5 to 3% and are close to those found in diamond inclusions from Sputnik pipe (Sobolev et al., 1997). The clinopyroxenes less enriched in Na_2O are often more ferriiferous.

In Prianabarie diopsides from the nests in dunites are even more depleted. Highly Na-Al varieties occur mainly in Ga pyroxenites transitional to eclogites enriched in Al and more ferriiferous.

Orthopyroxenes in Chompolo are usually enriched in FeO and CaO, rare (relic) depleted varieties were also found. In the Prianabarie they have common $\text{mg}'=0.91$ and are Al_2O_3 -poor (1.2%).

Cr-spinels in Aldan shield reveal a typical mantle trend from 9- to 56% Cr_2O_3 clustering in separate classes (Fig.2b).

Table 1 - Representative analyses of deep seated minerals from the Gornaya pipe, Aldan shield

	Gor G1	Gor G6	Gor G10	Gor G3	Gor G54	Gor G20	Gor G46	Gor 16	Gor 27	Gor 44	Gor 52	Gor 58	Gor 48
	Pyropes							Cr-Diopsides					
SiO_2	41.30	41.45	42.09	41.96	41.72	42.01	42.85	54.94	52.23	55.64	55.09	54.36	51.38
TiO_2	0.09	0.11	0.02	0.15	0.26	0.27	0.26	0.05	0.37	0.05	0.16	0.12	0.79
Al_2O_3	18.59	18.18	19.67	21.05	21.10	21.58	23.21	0.70	6.11	3.44	2.67	2.30	8.27
Cr_2O_3	7.16	6.42	4.43	3.56	2.21	1.72	0.17	0.41	1.05	2.51	2.17	1.82	0.02
FeO	8.39	8.60	8.30	9.83	11.05	9.38	8.44	3.40	3.09	1.56	1.49	1.53	5.73
MnO													
MgO	18.13	18.35	19.09	19.18	19.18	20.16	21.68	17.95	14.33	14.09	15.58	15.25	11.59
CaO	6.80	6.88	6.06	5.12	4.77	4.53	4.37	21.64	22.23	18.69	19.98	20.57	19.35
Na_2O	0.05	0.06	0.02	0.07	0.06	0.06	0.07	0.60	1.45	3.53	2.90	2.38	2.81
K_2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
NiO	0.03	0.00	0.01	0.01	0.00	0.00	0.00	0.03	0.04	0.04	0.01	0.04	0.01
Total	100.55	100.05	99.68	100.93	100.36	99.71	101.05	99.74	100.89	99.54	100.05	98.37	99.94
Fe/(Fe+Mg)	20.61	20.82	19.61	22.33	24.43	20.70	17.93	9.61	10.80	5.85	5.09	5.33	21.72

	Gor 232	Gor 211	Gor 236	Gor 244	Gorn 307	Gorn 300	Gor 403	Gor 409	Gor 418	Gor 419
	Enstatites				Phlogopites		Cr-Spinels			
SiO_2	57.38	57.94	56.01	55.07	40.73	39.61	0.00	0.01	0.01	0.02
TiO_2	0.02	0.00	0.00	0.03	3.84	0.202	0.03	0.10	0.03	0.03
Al_2O_3	3.31	1.72	1.54	2.74	11.62	14.53	36.42	12.27	57.51	43.42
Cr_2O_3	0.58	0.71	0.59	0.68	0.43	4.57	34.26	55.84	11.56	26.43
FeO	4.15	4.18	4.35	4.41	5.08	8.04	12.78	19.15	10.15	10.87
MnO			0.12	0.13						
MgO	34.85	35.73	36.12	34.90	22.78	18.73	15.12	10.15	19.09	16.54
CaO	0.29	0.18	0.36	0.77	0.007	0.015				
Na_2O	0.03	0.00	0.04	0.14	0.103	0.407				
K_2O	0.00	0.00	0.01	0.01	9.47	9.21				
NiO	0.06	0.06			0.135	0.027	0.08	0.08	0.38	0.16
Total	100.67	100.52	99.14	98.88	99.84	98.69	98.69	97.60	98.73	97.47
Fe/(Fe+Mg)	6.26	6.16	6.33	6.62	19.41	11.12	32.17	51.43	22.98	26.94

Table 2 - Compositions of the major and trace elements in minerals and host rock. Ogonyok pipe Aldan Shield

	OG-1 Gar	OG-2 Gar	OG-3 Gar	OG-4 Gar	OG-5 Cpx	OG-6 Cpx	OG-7 Cpx	OG-8 Cpx	63-4
	Garnets				Clinopyroxene				Lamproite
SiO ₂	40.65	38.75	41.74	41.34	54.12	54.61	54.17	54.54	38.89
TiO ₂	0.31	0.12	0.06	0.07	0.22	0.12	0.12	0.12	2.56
Al ₂ O ₃	18.27	20.52	19.03	18.17	0.44	2.69	2.27	1.73	7.36
Cr ₂ O ₃	6.01	0.01	5.52	6.36	0.87	2.27	2.01	1.40	0.00
FeO	8.36	26.78	8.50	8.37	4.49	1.83	1.75	2.22	12.57
MnO	0.43	0.71	0.47	0.44	0.15	0.04	0.06	0.07	0.37
MgO	19.06	7.30	19.12	17.60	17.29	15.42	15.74	17.28	19.00
CaO	5.70	6.11	5.90	6.20	21.31	20.24	20.14	20.98	3.37
Na ₂ O	0.07	0.02	0.02	0.04	0.70	2.51	2.30	1.30	0.14
K ₂ O	-	-	-	-	-	-	-	-	6.54
Total	98.86	100.32	100.35	98.59	99.61	99.73	98.589	99.63	90.80
mg ⁺	0.198	0.673	0.200	0.211	0.127	0.062	0.059	0.067	0.271
Ba	1.37	0.05	0.06	2.40	50.42	6.59	5.42	2.27	3166.03
La	0.01	0.19	0.02	0.10	2.78	3.04	1.16	0.85	311.43
Ce	0.03	0.59	0.18	0.23	12.11	8.40	3.47	3.20	519.31
Pr	0.02	0.09	0.06	0.10	2.25	1.35	0.52	0.56	57.92
Nd	0.24	0.75	0.54	0.80	11.15	6.70	2.08	2.80	204.07
Eu	0.12	0.41	0.15	0.13	0.78	0.30	0.16	0.14	7.31
Sm	0.26	0.92	0.37	0.26	2.54	1.12	0.52	0.55	30.82
Gd	0.47	2.27	0.35	0.38	1.75	0.68	0.31	0.28	16.67
Tb	0.09	0.73	0.05	0.06	0.22	0.08	0.04	0.04	1.95
Dy	0.63	6.69	0.26	0.34	1.03	0.34	0.20	0.15	8.77
Ho	0.14	1.87	0.05	0.07	0.14	0.04	0.03	0.02	1.40
Er	0.40	6.77	0.17	0.24	0.33	0.09	0.06	0.04	3.45
Tm	0.07	1.19	0.04	0.04	0.05	0.01	0.01	0.00	0.39
Yb	0.46	9.25	0.32	0.34	0.28	0.05	0.05	0.03	2.12
Lu	0.08	1.59	0.07	0.07	0.03	0.01	0.01	0.00	0.24
Hf	0.36	0.02	0.15	0.23	1.61	1.03	0.84	0.34	21.71
Zr	-	77.71	29.60	-	80.68	132.05	20.43	-	844.44
Ta	0.003	0.000	0.001	0.004	0.029	0.003	0.010	0.007	12.10
Nb	-	40.60	67.67	-	460.17	311.29	87.97	-	281.35
Th	-	2.20	2.60	-	18.70	30.15	5.80	-	26.56
U	-	2.13	4.02	-	10.42	27.00	5.02	-	6.76
Y	-	11.42	0.56	-	0.43	0.55	0.16	-	0.00
Sr	-	241.94	242.32	-	3312.79	39.89	776.33	-	2925.78
Rb	-	11.50	10.33	-	16.15	41.98	15.85	-	239.75
Cs	-	75.56	70.26	-	299.25	1358.72	286.66	-	1.91
Pb	-	22.80	25.79	-	59.82	54.19	28.88	-	14.04
Co	-	7.26	5.96	-	4.16	5.41	5.40	-	90.32
Cu	-	3.02	3.68	-	43.53	46.08	21.50	-	154.14
Zn	-	0.48	0.29	-	1.57	1.29	1.20	-	57.59

The deviation to the Fe- rich compositions with small Ti admixture was found only in (deepest) Cr-rich spinels. In contrast, practically all analyzed Cr-spinels from Priyanabarie are enriched in FeO and TiO₂ (up to 7%). In the range from 7 to 55% a few points plot on the mantle array. Ulvospinel in Istok are less chromious than those from Dyukon field (to 40-50% Cr₂O₃). Several compositions locate in intermediate trends between the mantle array and ulvospinel field on Cr₂O₃-Al₂O₃ diagram (Fig. 2d).

Ilmenite megacrysts from some pipes in the North Priyanabarie are close to those from the diamond bearing pipes

from the Central parts of the Siberian platform containing 6-11% MgO (Fig.3). Pyroxenites with the same MgO content (5-10%) in Ilm correspond to the pressures of about 50 kbar of the diamond facies mantle as calculated from the data for ilmenite-bearing pyroxenites (Table 4).

GEOCHEMISTRY The chemical features of the host lamproites and kimberlites in Aldan are indicative of typical primitive mantle melts and are close to those from the Alto Paranaíba (Brazil) (Carlson et al., 1996) being higher in trace element content (Fig. 4) (Table3). They correspond to low

Table 3 - Representative analyses of deep seated minerals from the Istok, and Dyuken, Prianabarie

Oxides	Garnets									
	IsGr5	IsGr6	IsGr8	IsGr10	IsGr12	IsGr13	IsGr15	IsGr16	IsGr18	IsGr21
SiO ₂	40.81	42.47	42.10	42.66	43.2	42.11	42.51	42.56	43.09	42.13
TiO ₂	0.11	0.07	0.46	0.22	0.21	0.30	0.24	0.09	0.262	0.347
Al ₂ O ₃	24.16	21.94	20.31	18.72	18.5	18.96	19.80	21.42	20.43	18.05
Cr ₂ O ₃	0.00	1.81	3.53	5.66	6.78	5.30	4.13	2.46	3.66	6.49
FeO	11.39	9.76	7.20	7.25	6.07	6.64	7.31	9.10	7.52	7.09
MnO	0.32	0.40	0.25	0.26	0.25	0.27	0.28	0.39	0.295	0.251
MgO	0.06	19.56	21.41	20.38	22.72	21.01	20.94	18.75	21.11	20.56
CaO	22.33	4.56	4.42	5.14	3.2	5.19	4.75	4.41	4.47	5.45
Na ₂ O	0.04	0.03	0.07	0.06	0.053	0.046	0.075	0.031	0.058	0.074
K ₂ O	0.00	0.00	0.00	0.00	0.004	0.008	0.001	0.005	0.007	0
Total	99.2	100.6	99.75	100.3	100.9	99.8	100.0	99.2	100.9	100.4
Fe/(Fe+Mg)	99.09	21.88	15.88	16.64	13.04	15.06	16.38	21.41	16.66	16.21

Oxide	Cr-Spinels						Ilmenites				
	ISCr1	ISCr2	ISCr3	ISCr4	ISCr5	ISCr6	IsIlm1	IsIlm3	IsIlm8	IsIlm30	IsIlm21
TiO ₂	5.51	9.22	8.44	8.06	6.86	0	49.39	52.53	53.38	46.78	47.67
Cr ₂ O ₃	4.53	4.2	2.49	4.66	4.45	14.32	0.50	0.76	0.58	0.41	0.28
Al ₂ O ₃	32.59	25.09	20.62	30.52	23.26	55.49	0.09	0.19	1.45	0.02	0.71
FeO	44.05	51.36	55.69	45.97	50.86	20.73	41.89	37.00	32.93	45.35	43.58
MnO	0.196	0.292	0.57	0.267	0.35	0.149	0.18	0.16	0.19	0.15	0.18
MgO	10.76	7.39	9.35	8.33	11.92	9.44	7.79	10.48	12.28	6.76	7.12
Total	97.6	97.5	97.2	97.8	97.7	100.1	99.8	101.1	100.8	99.4	99.5
Mg'	69.67	79.59	76.97	75.59	70.54	55.20	75.11	66.46	60.08	79.01	77.45

Dyukén

Oxides	Garnets									
	Dyu10	Dyu11	Dyu12	Dyu13	Dyu14	Dyu15	Dyu16	Dyu17	Dyu18	Dyu19
SiO ₂	42.01	42.44	42.21	42.17	41.94	41.27	41.25	42.20	42.41	42.38
TiO ₂	0.15	0.10	1.06	0.02	1.15	0.12	0.10	0.04	0.883	0.354
Al ₂ O ₃	19.69	22.53	21.45	19.27	21.66	16.42	18.21	19.10	18.99	20.58
Cr ₂ O ₃	5.65	1.78	0.87	6.47	0.918	9.87	7.44	6.38	5.6	4.66
FeO	8.08	9.72	10.61	7.78	10.94	7.00	6.83	6.63	7.63	6.33
MnO	0.44	0.36	0.31	0.40	0.35	0.30	0.28	0.24	0.304	0.229
MgO	19.53	19.47	20.20	19.59	20.13	18.88	20.14	20.89	20.24	22.02
CaO	5.24	4.64	4.79	6.15	4.75	6.7	6.17	5.67	5.66	4.63
Na ₂ O	0.06	0.07	0.11	0.05	0.058	0.011	0.045	0.086	0.075	0.07
Total	100.85	101.11	101.61	101.90	101.90	100.57	100.46	101.24	101.79	101.25
Fe/(Fe+Mg)	18.84	21.88	22.77	18.22	23.37	17.22	15.99	15.12	17.46	13.89

	Cr-Spinels						Ilmenites				
	DyuS1	DyuS2	DyuS3	DyuS4	DyuS5	DyuS6	IsIlm1	IsIlm3	IsIlm8	IsIlm30	IsIlm21
SiO ₂	0.246	0	0.08	0.483	0.063	0.035	0.067	0	0.041	0	0.001
TiO ₂	0.115	0.039	4.61	0.753	6.1	5.26	49.73	49.32	49.15	49.90	45.93
Al ₂ O ₃	7.43	47.08	6.06	21	5.69	12.99	0.55	0.24	0.58	0.52	0.25
Cr ₂ O ₃	62.14	21.98	45.45	33.18	40.3	29.73	0.70	0.15	1.15	0.12	0.20
FeO	18.68	12.89	28.12	28.67	36.29	40.11	36.76	39.70	38.78	40.09	46.61
MnO	0.353	0.169	0.29	0.258	0.412	0.342	0.31	0.29	0.26	0.27	0.25
MgO	11.2	18.85	14.54	17.17	11.23	11.54	10.73	7.76	9.11	8.97	6.22
Total	100.16	101.01	99.15	101.51	100.09	100.01	98.84	97.45	99.04	99.87	99.46
Fe/(Fe+Mg)	48.35	27.73	52.04	48.37	64.46	66.11	65.78	74.17	70.49	71.49	80.79

Figure 2 - Compositions of the garnets (a) and Cr-spinels (b) from mantle inclusions from Aldan shield and Priyanabarie (c)(d). 1 - Gornaya pipe, Aldan. 2 - Ogonek pipe, Aldan. 3 - Aldanskaya dike, Aldan. 4 - Istok, Priyanabarie. 5 - Dyuken, Priyanabarie. 6 - Xenoliths from pipe 17/63 Dyuken.

degree melting of the enriched mantle source with the modal abundances of garnet lherzolites.

The trace element compositions of the garnets and diopsides from Gornaya pipe, Chompolo field, Aldan, is common for the peridotites from lithospheric keels of cratons (Schmidtberger et al. 2001). Garnets REE patterns are slightly U shaped in the right part, Cr-diopsides reveal highly inclined patterns with high Lu/Yb_n ratios, HFSE (Nb, Ta, Zr, Hf, Y, Ti) depletion, close to primitive Ba, Th, U content and Pb peaks. Reconstructed by melting inversion the restite assemblage is essentially enriched in garnet comparing with the upper parts of mantle sections where they are close to common Ga-Sp lherzolites (Fig.5). Reconstructed parental melts for the clinopyroxenes and garnets together display the gradual decrease in HREE followed by the gentle deepening of U shape

depression. It reflects the rise of the Ga/Cpx proportion in the melting association (up to 5:1 and more).

THERMOBAROMETRY Thermobarometric estimates using clinopyroxene (Brey & Kohler 1990, McGregor 1974) and clinopyroxene thermobarometry (Nimis 2000) as well as the Cr-pyroxene barometry (Ryan et al. 1996) show that mantle sections beneath the Mesozoic pipes from the marginal parts of cratons usually start from the depth 130-140 km (40-45 kbar) (O'Reilly et al. 2001, Schmidtberger & Francis 2000) as determined also for pipes from the north of Siberian platform (Pokhilenko et al. 2000).

The orthopyroxene-based estimates show highly heated mantle for the Chompolo field in the upper mantle section as determined for Tanzania (Lee & Rudnick 2000). The cold

Figure 3 - Histogram of the MgO, Cr₂O₃, TiO₂ distribution in Ilmenites from Istok and Dyukon fields, Priabarie. 1 - Istok field. 2 - Dyukon field

Table 4 - Representative analyses of the xenolith minerals from anomaly 17/63 Priianabarie.

	Dunites-with Px-Garnets					Pyroxenites			Ga- pyroxenite			
	17/22	17/22	17/22	17_1	17_1	A21	A21	A65	A64	A64	A222	A222
Oxides	Opx	Ga	Sp	Cpx	Ga	Cpx	Opx	Cpx	Ga	Cpx	Cpx	Ga
SiO ₂	56.97	41.79	0.8	55.22	41.03	52.48	55.29	55.03	40.59	54.77	54.89	39.69
TiO ₂	0.17	0.81	1.82	0.15	0.39	0.908	0.238	0.2	0.441	0.424	0.292	0.466
Al ₂ O ₃	1.29	19.3	41.44	1.88	16.69	0.182	1.35	0.681	21.94	6.31	4.26	19.66
Cr ₂ O ₃	0.52	4.76	19.63	1.75	9.32	0.037	0.137	3.12	0.17	0.191	2.19	1.72
FeO	5.77	7.25	16.72	3.23	7.43	3.46	9.76	4.02	17.38	6.23	1.34	13.56
MnO	0.14	0.29	0.27	0.11	0.35	0.059	0.194	0.126	0.541	0.135	0.076	0.785
MgO	33.09	20.85	19.75	18.58	19.34	15.7	30.99	14.74	14.3	12.26	14.46	13.1
CaO	1.38	4.91	0.05	18.45	6.73	26.17	0.752	19.48	4.26	13.92	18.67	9.73
Na ₂ O	0.33	0.07	0.03	1.41	0.04	0.617	0.222	2.77	0.123	4.72	3.44	0.083
K ₂ O	0.04	0.02	0.04			0.017	0.008	0.004	0.006	0.147	0.015	0.007
Total	99.70	100.05	100.55	100.78	101.32	99.63	98.94	100.17	99.75	99.11	99.63	98.80
Fe/(Fe+Mg)	8.91	16.33	32.21	8.89	33.59	11.01	15.02	13.27	40.55	22.19	4.94	36.74

	Ilm Orthopyroxenite		Glimmerite			Megacrystals				
	A20	A20	A21			AM11	AM11	AM11	AM11	AM11
	Ilm	Opx	Ol	Phl	Ilm	Ilm	Ilm	Ilm	Ilm	Ilm
SiO ₂		54.52	39.57	43.24						0.074
TiO ₂	35.73	0.26	0.058	4.64	55.06	49.74	51.67	53.02	48.9	50.72
Al ₂ O ₃	0.489	1.33	0	14.2	0.586	0.104	0.571	0.45	0.148	0.558
Cr ₂ O ₃	0.379	0.173	0.016	0.273	1.75	0.32	0.126	0.091	0.039	0.06
FeO	55.12	9.77	15.54	6.95	30.46	39.78	37.94	32.61	40.71	37.93
MnO	1.05	0.194	0.155	0.045	0.35	0.305	0.283	1.01	0.687	0.256
MgO	5.92	30.84	43.95	20.47	11.57	7.69	8.55	11.9	7.2	9.09
CaO	0.026	0.804	0.048	0.065	0.035	0.017	0.026	0.043	0.032	0.015
Na ₂ O	0.147	0.212	0.032	0.321	0.035	0.031	0.019	0.115	0.043	0.061
K ₂ O	0	0.011	0.011	9.33	0.003	0.008	0.003	0.001	0.003	0.003
Total	98.86	98.11	99.38	99.53	99.85	98.00	99.19	99.24	97.76	98.77
Fe/(Fe+Mg)%	83.94	15.09	16.56	16.00	59.63	74.38	71.35	60.60	76.04	70.07

branch with the lower TP gradient close to 40 mw/m² obtained by this method is similar to those from the Somerset island - Nicos kimberlites (Schmidtberger & Francis 2001).

Clinopyroxene thermobarometry reveal much lower heating degree close to 35mw/m² or less. But a shallow hot branch also exists.

Close or higher heating degree (~ 38 mv/m²) was also found for the middle part of mantle (40-50 kbar); in Priianabarie the lower part (to 64 kbar) is represented by coarse porphyritic dunites with garnet- clinopyroxene nests. The upper part here consists from Fe- dunites and glimmerites which seem to be very heated.

DISCUSSION Construction of the mantle section
Thermobarometry, petrography and mineral compositions show that in Chompolo area the mantle is layered. The hot shallow spinel Fe-harzburgite (with more rare lherzolite) part is underlain by the Ga-lherzolites and then by Ga-pyroxenites (Ga-wehrlites or harzburgites). In Priianabarie shallow peridotites are depleted to dunite and harzburgites (the later are completely serpentinized) with the glimmerite interlayers. The

deeper garnet zone in Staraya river area is represented by Ga lherzolites in Ary-Mastakh, and in Dyuken fields by Ga-harzburgites and dunites. Determined depth of capture is as high as for the pipes from the central part of platform but due to depletion pyroxene bearing xenoliths are rare.

Reasons of the layering and heating In these two compared marginal regions of the Siberian platform, mantle xenoliths and their host melts represent post-plume mantle sections and products of high degree depletion and Fe- metasomatism of the lithosphere. Possible exhausting of the lower lithospheric mantle by the plume melts explains relatively shallow depth of the xenolith capture determined by the pyroxene thermobarometry and by Cr-Ni garnet thermobarometry (Pokhilenko *et al*, 2000). The depleted compositions typical for the marginal craton mantle are possibly caused by the influence of subduction and incorporation of depleted mantle wedges in craton structure. Griffin *et al* (1999) displayed the eclogite type garnets sinking to the south west of the Siberian platform, that can be explained as the submerging of the subduction plate. General metasomatism probably resulted

Figure 4 - Trace-element distribution for the kimberlite from Ogonek pipe, Aldan comparing with some other localities in the World. 1 - Lamproite, Aldan. 2 - Kimberlites, Siberian platform, (Nowell *et al.* 1998). 3 - Kimberlites and lamproites, Alto Paranaíba, Brazil, (Carlson *et al.* 1996). 4 - Kimberlites, Fennoscandia (Pelltonen *et al.* 2000). 5 - Kimberlites, China, (Tompkins *et al.* 2000)

from subduction-related fluids or melts. But high-Ti content of spinels in Priabaric and Fe-Ti enrichment of ilmenite orthopyroxenite and glimmerites may be explained by the plume melts influence.

The difference in the construction of mantle sections is due to ancient layering. The common feature is the pyroxenite layers at the level close to 40 kbars, which are determined also in other world regions (Kopylova *et al.*, 1999). But the shallow hot associations may be attributed to the plume influence.

Its influence is likely to have spread over the very wide area, since the Triassic volcanics are distributed far from the main flood basalt location in Siberian Platform, for example in Udzhinskoe uprise in the North and Saltumakov ridge in the South etc.

CONCLUSIONS In the Siberian platform the deep-seated Mesozoic melts represent relatively shallow marginal mantle sections starting from 45-40 kbar which is also found for the other Mesozoic kimberlitic fields in NE of Siberian platform (Pokhilenko *et al.* 2000). Heating and Ti-Fe metasomatism in the upper part of the mantle section are likely results from the basalt melt intrusion at a level shallower than 100 km. Plume influence is the most probable reason of the anomalous heating in lower part of mantle keel in Priabaric.

Acknowledgements To prospecting geologists who discovered and studied kimberlite pipes, and Amakinskaya expedition that make it possible the study these materials. To staff of ICP and EPMA laboratories in UIGGM SD RASc. Work is supported RBRF grants 99-05-65688, 00-05-65288. To reviewers of RBG for the suggestions to the manuscript.

References

- Ashchepkov I.V. 2001 Jd barometer for mantle peridotites and eclogites and thermal conditions of the lithospheric keels of cratons and their surroundings. GSA Annual Meeting. Boston November 5 - 8, 2001.
- Beard A.D., Downes H., Hegner E., Sablukov S.M. 2000. Geochemistry and mineralogy of kimberlites from the Arkhangelsk Region, NW Russia: evidence for transitional kimberlite magma types. *Lithos*, **51**:47-73.
- Boyd, F.R., Pokhilenko, N.P., Pearson, D.G., Mertzman, S.A., Sobolev, N.V., Finger, L.W., 1997. Composition of the Siberian cratonic mantle: evidence from Udachnaya peridotites xenoliths. *Contrib. Mineral. Petrol.*, **128**:228-246.
- Brey G.P., Kohler T., 1990 Geothermobarometry in four phase lherzolites II: new thermobarometers and practical assessment of using thermobarometers. *J. Petrol.*, **31**:1353-1378.
- Carlson R. W., Esperança S., Svisero D. P. 1996. Chemical and Os isotopic study of Cretaceous potassic rocks from Southern Brazil. *Contrib. Mineral. Petrol.*, **125**:393-405.
- Cull J.P., O'Reilly S. Y., Griffin W.L. 1991. Xenolith geotherms and crustal models in Eastern Australia. *Tectonophysics*, **192**:359-366.
- Ehrenberg S.N. 1982. Petrogenesis of garnet lherzolite and megacrystalline nodules from the Thumb, Navajo volcanic field. *J. Petrol.*, **23**:507-547.
- Franz L., Brey G.P., Okrusch M. 1996. Steady state geotherm, thermal disturbances, and tectonic development of the lower lithosphere underneath the Gibeon Kimberlite Province, Namibia. *Contrib. Mineral. Petrol.*, **126**:181-198.
- Griffin W.L., Ryan C.G., Kaminsky F.V., O'Reilly S.Y., Natapov L.M., Win T.T., Kinny P.D., Ilupin I.P. 1999. The Siberian lithosphere traverse: mantle terranes and the assembly of the Siberian Craton. *Tectonophysics*, **310**:1-35.
- Griffin W.L., Ryan C.G., Kaminsky F.V., O'Reilly S.Y., Natapov L.M., Win T.T., Kinny P.D., Jaques A.L. 1998. Kimberlite and lamproite diamond pipes. *AGSO J. Austral. Geol. and Geophys.*, **17**:153-162.
- Kaminsky F.V., Zakharchenko O.D., Davis R., Griffin W.L., Khachatryan-Blinova G.K., Shiryayev A.A. 2001 Super diamonds from Juina, Mato Grosso, state Brazil. *Contrib. Mineral. Petrol.*, **140**:734-753.
- Kopylova M.G.; Russell J.K.; Cookenboo H. 1999. Petrology of peridotite and pyroxenite xenoliths from the Jericho kimberlite: Implications for the thermal state of the mantle beneath the Slave craton, northern Canada. *J. Petrol.*, **40**:79-104.
- Kornilova V.P. 1997. Petrography and mineralogy of the calc-alkaline lamprophyres and eruptive breccias from Chompolo area. *Fatherland (Russian). Geology*, **9**:6-9.
- Kukkonen I.T., Peltonen P. 1999. Xenolith-controlled geotherm for the central Fennoscandian Shield: implications for lithosphere-asthenosphere relations. *Tectonophysics*, **304**:301-315.
- Kuligin S.S., Pokhilenko N.P. 1998 Mineralogy of xenoliths of garnet pyroxenites from kimberlite pipes of Siberian platform. *Extended Abstracts 7IKC. Cape Town*. pp.480-482.
- Lee C.-T., Rudnick R. L. 2000. Compositionally stratified cratonic lithosphere petrology and geochemistry of peridotite xenoliths from the Labait volcano, Tanzania. *International Kimberlite Conference, 7, The P.H. Nixon volume, Proceedings*, pp.: 503-521.
- MacGregor I.D. 1974. The system $MgO-Al_2O_3-SiO_2$: solubility of Al_2O_3 in enstatite for spinel and garnet-spinel compositions. *Am. Mineral.*, **59**:110-119.
- Nimis P., Taylor W. 2000. Single clinopyroxene thermobarometry for garnet peridotites. Part I. Calibration and testing of a Cr-in-Cpx barometer and an enstatite-in-Cpx thermometer. *Contrib Mineral Petrol.*, **139**:541-554.
- Nixon, P.H., Boyd, F.R. 1973. Petrogenesis of the granular and sheared ultrabasic

Figure 5 - The TRE composition of the deep seated mineral xenocrysts (a) and their parental melts, calculated with KD's, (b) from Aldan kimberlites.

nodule suite in kimberlite. In: Nixon, P.H. Ed. Lesotho Kimberlites. Cape and Transvaal, Cape Town, pp. 48-56.

Nowell G.V., Kempton P.D., Pearson D.G. 1998 Trace element and isotope geochemistry of Siberian Kimberlites. 71KC, Cape Town, Extended Abstracts, pp. 631- 633.

O'Reilly S.Y., Griffin W.L., Djomani P., Y.H., Morgan P. 2001 Are Lithosphere Forever Tracking Changes in Subcontinental Lithospheric Mantle Through Time. GSA Today 11/4:4-9.

Pearson D.G. 1999. The age of continental roots. Lithos, 48:171-194.

Peltonen P., Huhma H., Tyni M., Shimizu N. 2000. Garnet peridotite xenoliths from kimberlites of Finland: nature of continental mantle at an Archaean

craton - Proterozoic mobile belt transition. International Kimberlite Conference, 7, The P.H. Nixon volume, Proceedings, pp.: 664-676.

Pokhilenko N.P., Pearson D.G., Boyd F.R., Sobolev N.V.1991. Megacrystalline dunites: sources of Siberian diamonds. Carnegie Inst. Wash. Yearb., 90:11-18

Pokhilenko N. P., Sobolev N.V., Kuligin S. S., Shimizu N. 2000. Peculiarities of distribution of pyroxenite paragenesis garnets in Yakutian kimberlites and some aspects of the evolution of the Siberian craton lithospheric mantle. International Kimberlite Conference, 7, The P.H. Nixon volume, Proceedings, pp.: 690-707.

Ryan, C.G., Griffin, W.L., Pearson, N. 1996. Garnet Geotherms: a technique for

Figure 6 - TP estimates for the xenoliths from Siberian platform comparing with those from the other platforms.

derivation of P-T data from Cr-pyroxene garnets. *J. Geophys. Res.*, **101**:5611-5625.

Sablukov S.M., Sablukova L.I., Shavryina M.V. 2000. Mantle xenoliths from the kimberlite deposits of the Zymny Bereg Archangelsk diamondiferous province. *Petrology*, **5**:518-548.

Schmidberger S. S., Francis D. 2001. Constraints on the Trace Element Composition of the Archean Mantle Root beneath Somerset Island, Arctic Canada. *J. Petrology*, **42**:1095-1117.

Shilina G.N., Zeitlin S.M. 1959. About the first finding of the kimberlites in Aldan shield. *Soviet geology*, **10**:132-136.

Sobolev, N.V. 1974. Deep-Seated Inclusions in Kimberlites and the Problem of the Composition of the Upper Mantle (in Russian). Nauka Press, Novosibirsk, 264 pp. [English Translation (1977), ed. by F.R. Boyd, American Geophysical Union, Washington, DC, 279 pp.]

Sobolev N.V., Kaminsky F.V., Griffin W.L., Yefimova E.S., Win T.T., Ryan C.G., Botkunov A.F. 1997. Mineral inclusions in diamonds from the Sputnik kimberlite pipe, Yakutia. *Lithos*, **39**:135-157

Van Achterbergh E., Griffin W.L., Shee S.R., Wayatyt B.A., Sharma A.L. 1998. Natural trace element distribution coefficients for garnet clinopyroxene and orthopyroxene: variations with temperature and pressure. *Extended Abstracts 71KC*. Cape Town., pp. 934-936.

Wagner C., Deloule E., Mokhtari A. 1996. Richterite-bearing peridotites and MARID-type inclusions in lavas from North Eastern Morocco: mineralogy and D/H isotopic studies. *Contrib. Mineral. Petrol.*, **124**:406-421.

Manuscrito A-1303

Recebido em 22 de novembro de 2001

Revisão dos autores em 20 de dezembro de 2001

Revisão aceita em 21 de dezembro de 2001