EVOLUTION OF THE ANCIENT SUBCONTINENTAL LITHOSPERE FROM THE DEEP-SEATED AND LOWER CRUST XENOLITHS DATA FROM YACUTIAN KIMBERLITES.

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PT-data for deep-seated xenoliths from the Udachnaya pipe represented by metamorphic harzburgites, lherzolites and pyroxenites show a layered stratificated structure of the Upper Mantle in the central part of the Siberian platform (Anabar craton) up to depths of 210-220 km (Fig. 1). From the Obnazhennaya pipe geotherm the layered structure is recognized with reasonable confidence up to depth of 100-120 km for the Olenek craton.Correlation between petrological (Fig. 1a) and geophysical (Fig. 1b) cross-sections for the centre of the Anabar craton of the Siberian platform shows similarity in layered lithology and low-velocity zones position. The subjacent layer on geotherm (180-220 km) is generally composed of deformed garnet lherzolites and rarely of poorly deformed ilmenite peridotites (lherzolite, websterite). The low-velocity layer in the range of 195-250 km correspond to it on geophysical profile. The next layer of garnet pyroxenites, garnet olivine websterites (143-177 km) correlates well with low-velocity zone in the range of 145-160 km, whereas pyroxenite layer immediately underlying the crust is not directly correlated with two upper low-velocity zones on geophysical cross-section.

Thus, it is suggested that subcratonic lithosphere possesses a layered structure (Solovjeva et al., 1994) and is composed of thick alternating plates, layers predominately of lherzolite-harzburgite and pyroxenite-websterite compositions. Characteristic metamorphic structures of these rocks, presence of exsolved megacrystals of primary high-temperature orthopyroxene in Sp, Sp+Ga, and Ga garzburgites and lherzolites and analogous ortho- and clinopyroxene megacrystals in pyroxenites and websterites of different facies obviously indicate the existense of premetamorphic "hot" stage in lithospheric protolith history. In separate composite samples with contacts between websterites and pyroxenites on the one hand, and lherzolites and harzburgites, on the other, uniform mineral composition and the metamorphism of already existed contact is observed. It may be assumed that lithospheric protolith including the protocrust is of ancient magmatic origin and it was initiated as a layered structure due to crystallization of great magma reservoire on the Earth's surface (Solovjeva et al., 1994) as evidenced by high initial temperatures calculated for high temperature pyroxene "precursor" from pyroxenites, websterites and metabasite granulites from the Udachnaya, Obnazhennaya and Slyudyanka pipes (Fig. 2).

Presence of thick pyroxenite layers in the mantle subcratonic lithosphere and their possible ancient magmatic origin indicate the great role of high-temperature pyroxene fractionation in initial melts. Possibilities of such pyroxene fractionation in liquid corresponding to average peridotite spinifex-textured komatiites from Abitibi (Condy, 1981) are given in Table 1. Pyroxenite and websterite bulk composition containing exsolved pyroxene megacrystals composed of parallel alternating exsolution lamella: Cpx+Opx+Ga; Cpx+Opx+Sp; Cpx+Opx+Sp+Ga were taken as fractionating materials. It is assumed that these rocks at "hot" protholith stage were monomineral cumulates composed of homogenous mixed pyroxenes ("precursor"-pyroxene). A short sample description is given in table captions. Calculation of residual liquid were made by proportional subtraction of 30% of fractionating materials from the A composition.

During removal of composition 74/161, possibly represented at hot stage megacrystal cumulus of Ca, Al-rich orthopyroxene from liquid A, the residual liquid L14 enriched in Ti, Ca, Fe and depleted in Mg is displaced to high-magnesian basalt compositions. "Precursor"-pyroxene composition 74/161 is rather close to liquidus pyroxene crystalliized at 4GPa and 1700^{0}C from Al-depleted komatiite in experiments of Wei et al. (1990). Residual liquid composition L14 is in general similar to average ferrugenous composition of pyroxenites, websterites from the Obnazhennaya pipe C4. Ferrugenous garnet pyroxenites from the above pipe C6 and ungranitizated metabasite granulites from the Obnazhennaya, Slyudyanka and Udachnaya pipes PC show a tendence to less magnesian basalts.

30% fractionation of 74/300 represented at hot stage a cumulus of homogenous mixed crystals on the clinopyroxene basis leads to very insignificant increase in MgO and CaO contents. 74/300 composition is comparable to liquidus pyroxene crystallized from Al-undepleted komatiite at 5.5 Gpa and 1780^{0}C (Wei et al., 1990). 30% fractionation of 7/73 and 6/73 also represented at hot stage the cumulus homogenous pyroxenes, displaces residual liquids L15 and L16 to ultrabasic compositions containing 28-31 wt.% of MgO. L16 residual liquid as a whole approaches starting HSS-15 komatiite (Wei et al., 1990), except for CaO/Al_2O_3 ratio. CaO/Al_2O_3 ratio in calculated residual liquids varies from 0.89 to 1.73 (L18)

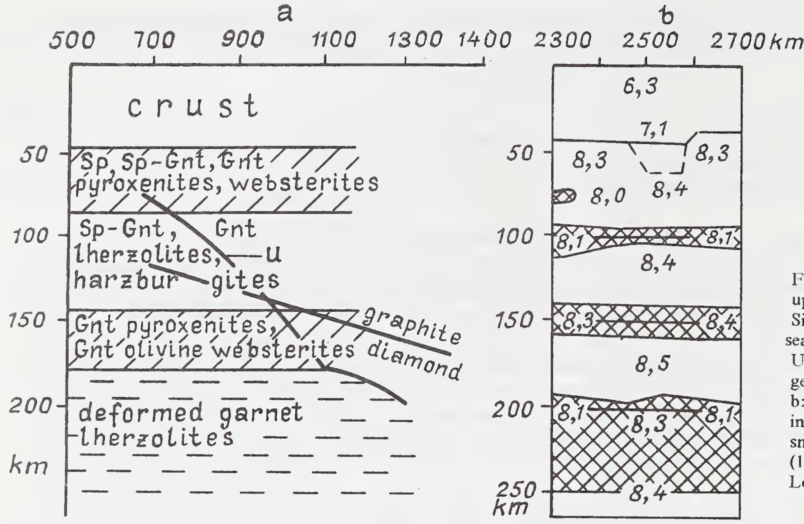

Fig.1. a: Layered structure of the upper mantle in centre of the Siberian platform from the deep-seated xenoliths PT-data from the Udachnaya pipe; U - "Udachnaya" geotherm,(Solovjeva et al.,1994). b: The part of cross-section in interval 2300-2700 km along seismic profile II after Egorkin et al. (1984). Numbers are Vp values. Low-velocity layers are shown.

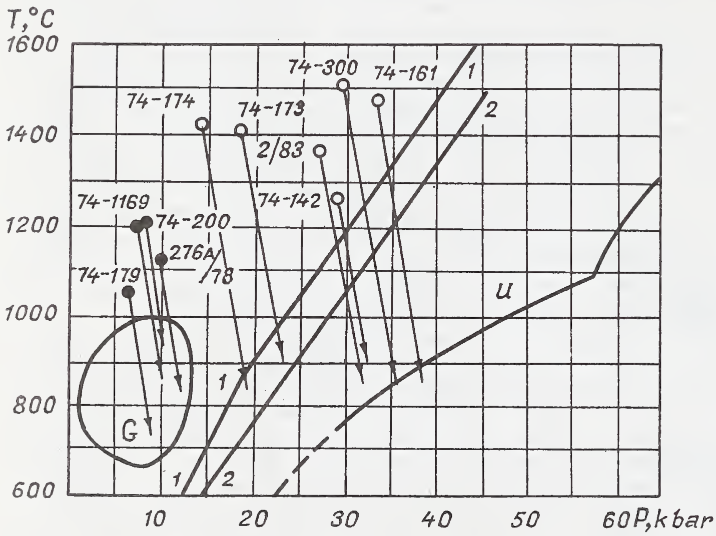

Fig.2. PT-evolution for megacrystalline pyroxenites, websterites with large exsolved pyroxene crystalls (open cirles)and metabasite granulites with relict exsolved pyroxene crystals (solid cirles) from Udachnaya, Obnazhennaya, Slyudyanka pipes. U - "Udachnaya" geotherm; 1-1-1 and 2-2 are lines of spinel - garnet transition (McGregor, 1965 and Ringwood et al., 1964). G - granulites field after Harley (1989).

that indicate possible melt composition change from primary Al-undepleted composition to residual Al-depleted one.

Thus, using the Siberian platform as an example , it can be shown that craton protoliths represent the layered structures originated during solidification of great magma reservoires on the Earth's surface and they are similar to layered intrusions. Fractionation of high-temperature mixed pyroxenes and possibly of olivine initiated cumulus layers of high-temperature harzburgites converted to Sp, Sp-Ga, Ga lherzolites and harzburgites of common type during cooling and metamorphism. Cumulus layers high-temperature clinopyroxenes and orthopyroxenes subsequently initiated pyroxenite-websterite layers. Protocrust originated during crystallization of residual basite liquids.

Evident differencies in metamorphism and in average estimated compositions of protoliths from the Anabar and Olenek cratons suggest that different cratons resulted from magma reservoirs of different ages and cratonisation constituted pressing and soldering of different-age protoliths of various thickness which were in different physical state (temperature, viscosity, plasticity etc.).

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Table 1. The calculation of pyroxene fractionation from the initial komatiitic liquid.

Sample No	A	74/161	HSS-15 (138)	L14	C4	C6	PC	74/300	L11	M620 (260)	7/73	L15	6/73	L16	HSS-15	569/80	L18
SiO_2	46,91	54,04	54,2	43,86	50,16	47,24	47,50	49,79	45,67	52,7	48,32	46,30	50,39	45.41	46,77	48,24	46,34
TiO_2	0,39	0,08	0,06	0,53	0,19	0,07	1,14	0,31	0,41	0,16	0,16	0,48	0,11	0,51	0,33	0,23	0,46
Al_2O_3	8,16	4,88	2,46	9,57	9,93	13,61	15,65	7,79	8,31	5,68	12,34	6,37	12,55	6,27	3,42	13,53	5,86
FeO*	9,95	5,05	7,63	12,04	8,13	11,17	12,14	9,47	10,16	7,95	8,69	10,49	6,13	11,59	11,26	12,73	8,76
MgO	26,24	33,67	32,7	23,06	21,68	16,20	9,63	25,15	26,70	26,8	21,32	28,34	15,68	30,77	31,51	21,60	28,23
CaO	7,88	1,86	2,56	10,86	8,17	9,81	11,05	5,89	8,73	6,75	7,88	7,88	13,15	5,61	5,67	2,65	10,11
Na_2O	0,14	0,21	0,04	0,11	1,30	1,40	1,83	1,23	0,00	0,03	0,84	0,00	1,82	0,00	0,12	0,33	0,06
K_2O	0,07	0,09	-	0,06	0,16	0,14	0,70	0,12	0,06	-	0,25	0,00	0,16	0,03	0,08	0,29	0,00
P_2O_5	0,02	0,02	-	0,02	0,02	0,03	0,17	0,04	0,01	-	0,02	0,02	0,01	0,02	-	0,02	0,02
MnO	0,24	0,10	0,15	0,30	0,15	0,20	0,19	0,21	0,25	0,16	0,18	0,27	-	0,24	0,19	0,38	0,19
Cr_2O_3	-	-	-	-	0,11	0,13	-	-	-	-	-	-	-	-	-	-	-
CaO/Al_2O_3	0,97	0,38	1,04	1,13	0,82	0,72	0,71	0,76	1,05	1,19	0,64	1,24	1,05	0,89	1,66	0,20	1,73

A, average periodite komatiite with spinifex texture from Abitibi, Kanada (Condy, 1981); 74/161, megacrystalline orthopyroxenite composed by large (2-7 cm) exsolved orthopyroxenite crystals (layered parallel intergrowths of Cr-diopside, garnet, spinel) in finegrained matrix of the same minerals, 20%, Udachnaya pipe; HSS-15(138), liquidus pyroxene, crystallized from Al-depleted komatiite by 1700 C and 4GPa (Wei et al., 1990); L14, calculated residual liquid after 30% fractionation of composition 74/161 from A; C4, average of 4 ferriferous garnet pyroxenites, websterites, Obnazhennaya pipe; C6, avarage of 6 ferriferous garnet clinopyroxenites, Obnazhennaya pipe; PC, average metabasite granulite from Udachnaya, Obnazhennaya and Slyudyanka pipes (Solovjeva et al., 1994); 74/300, garnet websterite, composed by large (5-7,5 cm) exsolved pyroxene crystalls (53 wt% Cpx, 47 wt% Opx) in the fine-grained Cpx-Opx matrix, 10%, Obnazhennaya pipe; L11, calculated residual liquid after 30% fractionation of composition 74/300 from A; M620(260) liquidus pyroxene cristallized from Al-undepleted komatiite by 1780 C and 5,5 GPa (Wei et al. 1990); 7/73, megacrystalline garnet clinopyroxenite composed by large (1,5-5 cm) exsolved clinopyroxene crystals (10 wt% Opx, 90 wt% Cpx) in finegrained matrix of the same minerals and garnet, 20%, Obazhennaya pipe; L15, calculated residual liquid after 30% fractionation of composition 7/73 from A; 6/73, megacrystalline garnet clinopyroxenite, composed by large (2-5 cm) exsolved clinopyroxene crystals (15-20 wt% Opx, 80-85 wt% Cpx) in finegrained matrix (Gnt, Opx, Cpx), Obnazhennaya pipe; L16, calculated residual liquid after 30% fractionation of composition 6/73 from A; HSS-15, Al-depleted komatiite from Barberton (Wei et al., 1990); 569/80, ferriferous granoblastic garnet orthopyroxenite, Udachnaya pipe; L18, calculated residual liquid after 30% fractionation of composition 569/80 from A; The analyses A, 74/161, C4, C6, PC, 74/300, 7/73, 6/73, 569/80 are normalized to 100% on avolatile free basis. * Total iron as FeO.