Sr, Nd isotopic data of kimberlites and related rocks from North of Yakutian kimberlite province (Russia)

Kostrovitsky[1], S.I., Morikiyo[2], Toshirio

1. Institute of Geochemistry of Siberian Branch, Irkutsk 664033, Russia
2. Department of Geology, Shinshu University, Japan

Sr and Nd isotopic data have been obtained for the first time for the kimberlites and related rocks (alnoite and carbonatites) from the North of Yakutian kimberlite province. The analyses were performed at Shinshu University via the mass-spectrometer Finnigan MAT 262. The procedure of extraction and further spectrometric analysis of Rb, Sr, Sm and Nd were described by H. Kagami et.al. (1987,1989).

The rock collection, sampled from the pipes of northern fields of Yakutian province (Kuronakh field: Malokuonamskaya, Universitetskaya pipes; Ari-Mastakhsk: Rudnyi dvor, Sportivnaya, Victoriya, Polyarnaya pipes; Nomokhtokh: Prima pipe; Orto-Yarginsk: Anomaly N 15/85; Kuoiskoe (Obnazhennaya, Montechellite, Seraya pipes) has been studied. The first four fields belong to the Lower Mesozoic subprovince, which is confined to the eastern margin of the Anabar shield. The Kuoiskoe field is situated on the north-eastern margin of the Siberian platform and filled mainly with the youngest (Jurassic) kimberlites and alnoites (Brakhfogel, 1984; Kornilova et al, 1983).

The studied kimberlites and alnoites are characterized by wide variations of chemical composition and primarily lithophile oxides (TiO_2 - 0.18-5.07; Al_2O_3 - 1.97-5,20; K_2O - 0.40-2.92; P_2O_5 - 0.47-1,71) and on the whole reflects the features of composition of rocks, filling the north fields of Yakutian kimberlite province. The carbonatite breccias are mainly of calcite composition (carbonate component makes up more than 50%).

Table 1 gives the isotopic data. The plot with the coordinates $(^{87}Sr/^{86}Sr)0$ - εNd (Fig.1) indicates the complete correlation of isotopic characteristics for kimberlites and related rocks from the north Yakutian province with those for basaltoid kimberlites of group I from different Mir provinces. Almost all points of isotopic compositions lie in the area of primitive and insignificantly depleted mantle. The isotopic characteristics of kimberlites and alnoites for the investigated pipes are similar. The dependence of Sr and Nd isotopic compositions on the kimberlite and alnoite composition is not available.

The majority of samples, independent on rock type, are marked by a relatively low initial $^{87}Sr/^{86}Sr$ ratios, varying in the range from 0.70346 to 0.70436. The exception is the kimberlite from the Obnazhennaya pipe. The increased $^{87}Sr/^{86}Sr$ value for this kimberlite is due to the more intensive alteration of the rock. It should be noted that diamond-bearing Paleozoic kimberlites as opposed to the kimberlites and related rocks of the north of Yakutian province are marked (Kostrovitsky,1986) by higher and wider range of isotopic composition Sr (0.704-0.711). It indicates the more intensive impact of essentially carbonate sedimentary cover on the Paleozoic kimberlites, the thickness of which in the south of the Yakutian province is about 2 km (in the north, in the Near-Anabar the thickness amounts to the first hundred meters).

$^{143}Nd/^{144}Nd$ initial ratio in kimberlites and related rocks from the north of the Yakutian province mainly varies in a narrow range, not depending on rock type. The dependence of ratio values on the rock age is obvious (Fig.2). It was established earlier (Basu et al, 1979; Nelson et al, 1988), that the correlation between the initial isotope Nd (and Sr) composition in the rocks, having the mantle source, and their age is a global phenomenon, indicating the primitive non-depleted source nature. On the correlation plot Nd isotopic compositions for different-age kimberlites of the Yakutian and other Mir provinces lie on or near the evolution line of $^{143}Nd/^{144}Nd$

ratio for the CHUR source. An insignificantly greater deviation from the evolution line of isotopic data for kimberlites and related rocks from the north of Yakutian province as opposed to the south diamond-bearing rocks suggests the relations of the first ones with a more depleted mantle source of substance. As it is known, a primitive source is related to the asthenosphere source while the depleted one is associated with shallow lithosphere source.The significance of the latter in the formation of kimberlites and related rocks from the north of Yakutia conforms to a well-known fact of a marked decrease of diamonds and associated minerals, as well as the disappearance of most deep-seated mantle xenoliths.

The obtained isotopic data suggest the correlation of kimberlite diamond-bearing capacity with εNd values, as a measure of proximity to the chondrite model of a source. All three samples of non-diamond kimberlites and associated rocks of the Kuoskoe field are characterized by the maximum εNd value (+ 4.71 - + 5.25). The Malokuonamskaya pipe, the only kimberlite body from the considered above with relatively high diamond-bearing capacity is marked by εNd value, which is the most proximate to the chondrite one (-0.61). It is more likely that a significant deviation from the evolution line of $^{143}Nd/^{144}Nd$ CHUR ratio towards both the enrichment and depletion is a negative factor for diamond-bearing kimberlites.

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REFERENCES

Agashev A.M., Orihashi Y., Watanabe T., Pokhilenko N.P., Serenko V.P. (in press) Sr-Nd isotope and trace elements geochemistry of Siberian kimberlites.

Basu, A.R., Tatsumoto M. (1979) Science, v. 205, p. 398-400.

Brakhfogel F.F. (1984) Geological aspects of kimberlitic magmatism of the north-east of Siberian platform. Yakutsk, Sib. br. of Acad. Sci., 128p. (in Russian)

Kagami, H., ., Iwata, M., Sano, S. and Honma, H.(1987) Technical Rep. ISEI Okayama Univ., ser. b.4. p. 1-16.

Kagami, H., Yokose, H. and Honma, H. (1989) Geochem. J., v. 23, p. 209-214.

Kornilova V.P., Nikishov K.N., et al, 1983, Atlas of textures of kimberlitic rocks. Moskow, Nauka, 159p. (in Russian)

Kostrovitsky S.I. Geochemical features of minerals from kimberlites. Novosibirsk, Nauka, 264p. (in Russian)

Smith C.B. // Nature. 1983. V.304. P. 51-54.

Fraser K.J., Havkesworth C.J. et al. // Earth Planet. Sci. Lett. 1985/86. V. 76. P. 57-70.

Nelson D.R., Chivas A.R., et al. (1988) Geochim. Cosmochim. Acta, v. 52, p. 1-17.

Mitchell R.H. (1986) Kimberlites: mineralogy, geochemistry, and petrology. New York: Plenum Press, 442p.

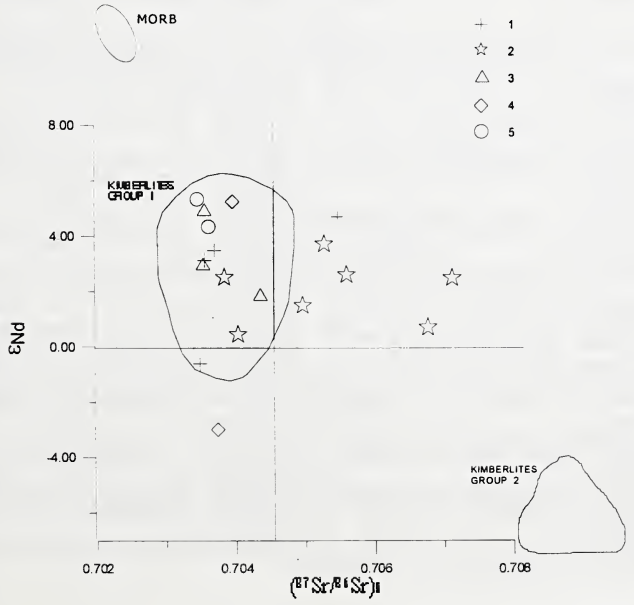

Fig. 1. Isotopic composition of Sr and Nd in kimberlites and related rocks of Yakutian province. 1,3,4,5 - correspond successively to kimberlites, porphirites, alnoites and carbonatites from North of Yakutian province; 2 - diamondferous kimberlites from South of Yakutian province (data of Agashev et al).

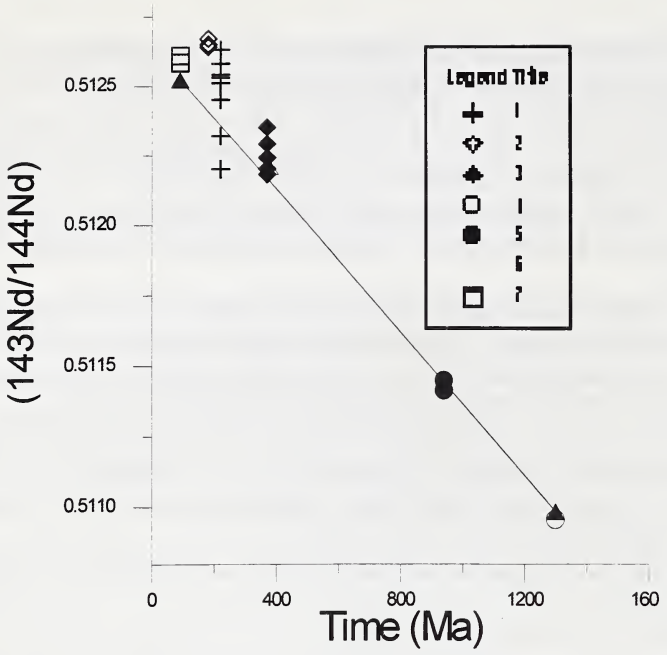

Fig. 2. Initial 143Nd/144Nd ratios versus age of emplacement for kimberlites and related rocks. 1-3 - Yakutian province: 1- Anabar region; 2- Kuoikskoe field; 3- southern diamondferous fields (Agashev et al); 4-pipe Premier, Africa; 5- Indian pipes L1, L2; 6- USA, Colorado-Wyoming, pipe Nix; 7- S.Africa pipes (Smith, 1983). The line represents 143Nd/Nd144 evolution of the achondrite Juvinas (Smith, 1983).

Tabl. 1. Isotopic composition of Sr and Nd in kimberlites and related rocks of the North of Yakutian province

	sample	Pipe	Rb, g/t	Sr, g/t	$^{87}Sr/^{86}Sr$ $\pm\sigma$	$(^{87}Sr/^{86}Sr)_0$	Sm, g/t	Nd, g/t	$^{143}Nd/^{144}Nd$ $\pm\sigma$	$(^{143}Nd/^{144}Nd)_0$	εNd
1	7-276	Obnajen-naya	48.6	1790	0.705674 0.000014	0.70547	14.4	108	0.512740 0.000014	0.51265	4.71
2	78-131	Malo-Kuonam-ska	114	1900	0.704032 0.000012	0.70349	15.8	113	0.512443 0.000014	0.51232	-0.61
3	78-1166	Universi-tetskaya	62.9	1280	0.704000 0.000013	0.70356	17.8	132	0.512630 0.000014	0.51251	3.12
4	90-15	Polyar-naya	66.8	2030	0.703997 0.000012	0.70370	23.2	153	0.512663 0.000014	0.51253	3.49
5	7-93	Seraya	20.4	551	0.703869 0.000014	0.70356	19.3	136	0.512745 0.000014	0.51252	4.97
6	90-21	Rudni dvor	111	1284	0.704328 0.000014	0.70354	14.6	96.6	0.512677 0.000014	0.51254	3.75
7	90-56	Sportiv-naya	97	1190	0.705100 0.000012	0.70436	15.1	104	0.512576 0.000014	0.51245	1.89
8	7-473	Monticel-liting	73.3	1220	0.704401 0.000012	0.70396	16.8	116	0.512777 0.000012	0.51267	5.25
9	90-60-1	Victoria	70.7	1360	0.704215 0.000011	0.70374	11	66.3	0.512344 0.000018	0.51220	-2.99
10	78-1555	Prima	12.4	7070	0.703476 0.000014	0.70346	125	1450	0.512701 0.000009	0.51263	5.33
11	90-74	Anomaly 15/85	40.8	3860	0.703712 0.000014	0.70362	32.4	275	0.512678 0.000014	0.51258	4.34

Note: 1-4 - kimberlites; 5-7 - picritic porpherites; 8-9 - alnoites; 10-11 - carbonatites.