SR AND ND ISOTOPIC DIFFERENCE BETWEEN KIMBERLITES AND CARBONATITES FROM SIBERIA

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Whole-rock Sr and Nd isotopic compositions of 31 kimberlite samples and 38 carbonatite samples from the Siberian Platform were obtained. Initial Sr and Nd isotopic ratios were calculated by using ages from literatures.

The aims of the study are

to elucidate the general features in Sr and Nd isotopic ratios for kimberlites occurring in the Yakutia district,

to compare Sr and Nd isotopic features of kimberlites with those of carbonatites in order to examine the genetic relationship between the rocks.

The kimberlites in the Yakutia province occur in the four different zones; Zone 1 (Olenyok-Anabar zone), Zone 2 (Daldyn-Olenyok zone), Zone 3 (Viluy-Marhinsk zone), and Zone 4 (South boundary of the Siberian platform). The distribution of those zones and the location of each kimberlite field are described in Afanasiev et al., 1995. The estimated ages of the kimberlites are shown in Table 1. Kimberlite samples investigated in this study were taken from all the zones above.

Carbonatites occurring in the Siberian Platform have been classified into two groups on the basis of their initial Sr and Nd isotopic signatures; Group 1 carbonatites have isotopically depleted feature whereas Group 2 carbonatites have enriched feature (Morikiyo et al., 2001). The Guli, Essei, Kiiskii, Srednetatarskii, Bolshetagninskii, Nizhnesayanskii, Vehnesayanskii, Zhidoy, Arbarastah, Ingili, Ozernyi and Koksharovskii carbonatite bodies are classified as Group 1. The Malomurunnskii and Khani bodies are Group 2. It should be noted that the age of carbonatite does not correlate with that of kimberlite, and that an occurrence of carbonatite is not found in the kimberlite fields above, with the exception of Anabar province (Kogarko et al., 1995).

The isotope analytical results are as follows: Kimberlites have initial eNd values ranging from +1.6 to +4.6, with the exception of the sample from Ingashi field. The initial eSr values range from -14.8 to +44.4(Table 2). Data points are scattered within the upper quadrant of the eNd vs. eSr diagram. But a linear arrangement parallel to the horizontal axis (eSr axis) is seen. For example, the eNd values for the samples from the Kuoika kimberlite field (Zone 2) are nearly constant (+3.5), but their eSr are variable, ranging from -11 to +28(Fig.1). This radiogenic Sr enrichment is interpreted as being due to the results of isotopic exchange with ground waters having high $^{87}Sr/^{86}Sr$ ratios. Thus we exclude such data from our consideration. Then it is seen that the unaltered kimberlites from the Siberian Platform have isotopic compositions ranging from -1.6 to +4.6 for initial eNd values, and from -14.8 to +2.4 for initial e Sr values (Fig.2). This compositional range is essentially similar to that of Group 1 kimberlite in South Africa.

The isotopic data for Group I carbonatites fall in a narrow field in the depleted quadrant in the eNd vs. eSr diagram. They have initial eNd values ranging from +2.7 to +7.0, and initial eSr ranging from -20 to –4(Morikiyo et al., 2001; Fig.2). One-half of the carbonatite samples of Group 1 have eNd values higher than +4.6. By contrast, all the kimberlites have eNd values lower than +4.6. Thus, it is clear that kimberlites and carbonatites were not derived from the same source material. It is concluded that kimberlite and carbonatite are not genetically related.

Table 1: List of kimberlite fields of the Siberian Platform

Zone		Kimberlite field	Age(Ma)
1	Olenyok-Anabar zone	Ari-Mastah, Luchakan, D'uken	Mesozoic (220, 180?)
2	Daldyn-Olenyok zone	Daldin, Alakit	Paleozoic (360)
2	ditto	Kuoika	Mesozoic (110-140)
3	Viluy-Marhinsk zone	Malo-Botuobin	Paleozoic (360)
4	South boundary of Siberian platform	Ingashi	Proterozoic (1268)
		South Anabr	250
		Haramay	250

Table 2a: Nd isotopic results for kimberlites

Sample	Sm (ppm)	Nd (ppm)	$^{147}Sm/^{144}Nd$ (atomic)	$^{143}Nd/^{144}Nd$ (measured)	$^{143}Nd/^{144}Nd$ (initial)	åNd
Ari-Mastah(220Ma)						
78-1534	11.4	77.2	0.0891	0.51259	0.51246	2.1
Malo-Kuonamk (220Ma)						
78-1003	19.4	146	0.0807	0.51267	0.51255	3.8
78-1185	18.1	135	0.0809	0.51264	0.51252	3.2
78-1215	9.01	65.7	0.0830	0.51259	0.51247	2.2
Luchakan (220Ma)						
78-1380	14.1	101	0.0849	0.51261	0.51249	2.6
78-1395	25.2	111	0.1366	0.51259	0.51239	0.7
99-3	20.7	148	0.0849	0.51240	0.51227	-1.6
99-14	25.4	172	0.0892	0.51262	0.51249	2.6
Starorechinsk (180?Ma)						
78-1565	105	913	0.0695	0.51266	0.51258	3.4
90-67	10.2	82.7	0.0747	0.51269	0.51260	3.8
78-1610	13.5	109	0.0746	0.51269	0.51260	3.8
Haramay (250Ma)						
Xp-10	9.33	68.2	0.0827	0.51253	0.51240	1.6
Xp-8	16.4	120	0.0831	0.51255	0.51241	1.8
Xp-11	19.3	142	0.0822	0.51252	0.51239	1.4
Ingashi (1268Ma)						
NH-1	29.8	286	0.0631	0.51100	0.51048	-10.3
Daldin (360Ma)						
01-280	10.8	81.5	0.0802	0.51257	0.51238	4.0
Alakit (360Ma)						
01-361	11.8	114	0.0624	0.51254	0.51239	4.3
Malo-Botuobin (360Ma)						
00/289	12.1	87.4	0.0835	0.51261	0.51241	4.6
Verhna-Muna (360Ma)						
9-200	10.6	68.1	0.0943	0.51262	0.51240	4.3
9-154	12.8	92.8	0.0831	0.51247	0.51227	1.9
Kuoika (110-140Ma)						
7-191	20.9	125	0.1012	0.51272	0.51263	3.4
7-483	32.4	248	0.0790	0.51271	0.51264	3.5
7-487	9.52	65.6	0.0877	0.51278	0.51270	4.6
7-78	9.47	67.8	0.0844	0.51274	0.51267	4.1
7-384	15.7	117	0.0809	0.51271	0.51263	3.4
7-388	4.06	30.0	0.0817	0.51272	0.51264	3.6
South Anabar (220Ma)						
001-11	15.0	93.8	0.0964	0.51247	0.51233	-0.4
Chomurdah(360Ma)						
7-460	15.9	97.9	0.0985	0.51256	0.51233	3.1
D'uken (220Ma)						
97-192	20.8	136	0.0923	0.51266	0.51253	3.4
97-128	37.2	261	0.0862	0.51267	0.51255	3.7
97-90	18.6	115	0.0981	0.51267	0.51253	3.4

Table 2b: Sr isotopic results for kimberlites

Sample	Rb (ppm)	Sr (ppm)	$^{87}Rb/^{86}Sr$ (atomic)	$^{87}Sr/^{86}Sr$ (measured)	$^{87}Sr/^{86}Sr$ (initial)	å Sr
Ari-Mastah(220Ma)						
78-1534	67.5	595	0.3281	0.70503	0.70400	-3.4
Malo-Kuonamk (220Ma)						
78-1003	55.3	1440	0.1109	0.70416	0.70381	-6.1
78-1185	72.3	806	0.2595	0.70401	0.70320	-14.8
78-1215	31.1	1170	0.0769	0.70626	0.70602	25.2
Luchakan (220Ma)						
78-1380	141	635	0.6442	0.70587	0.70385	-5.5
78-1395	74.2	776	0.2765	0.70445	0.70359	-9.3
99-3	55.2	785	0.2033	0.70445	0.70381	-6.1
99-14	39.7	1360	0.0847	0.70401	0.70375	-7.0
Starorechinsk (180?Ma)						
78-1565	25.6	2730	0.0271	0.70364	0.70358	-10.1
90-67	36.5	722	0.1462	0.70387	0.70349	-11.3
78-1610	33.8	741	0.1319	0.70459	0.70426	-0.5
Haramay (250Ma)						
Xp-10	31.7	601	0.1525	0.70513	0.70459	5.4
Xp-8	84.5	304	0.8042	0.70680	0.70394	-3.8
Xp-11	74.7	1550	0.1392	0.70460	0.70411	-1.4
Ingashi (1268Ma)						
NH-1	84.3	2580	0.0944	0.70783	0.70613	44.4
Daldin (360Ma)						
01-280	18.9	1110	0.0494	0.70460	0.70435	3.9
Alakit (360Ma)						
01-361	27.2	749	0.1052	0.70465	0.70411	0.5
Malo-Botuobin (360Ma)						
00/289	21.8	668	0.0945	0.70391	0.70342	-9.3
Verhna-Muna (360Ma)						
9-200	117	1000	0.3362	0.70611	0.70439	4.4
9-154	93.5	1810	0.1497	0.70717	0.70641	33.1
Kuoika (110-140Ma)						
7-191	89.3	1120	0.2302	0.70441	0.70395	-5.4
7-483	15.2	849	0.0518	0.70430	0.70420	-1.9
7-487	115	749	0.4436	0.70446	0.70358	-10.8
7-78	43.3	1220	0.1027	0.70464	0.70444	1.5
7-384	72.6	2190	0.0958	0.70527	0.70508	10.6
7-388	155	511	0.8761	0.70806	0.70632	28.1
South Anabar (220Ma)						
001-11	135	2060	0.1898	0.70500	0.70441	2.4
Chomurdah(360Ma)						
7-460	66.8	1010	0.1920	0.70601	0.70502	13.4
D'uken (220Ma)						
97-192	44.2	825	0.1548	0.70430	0.70382	-6.1
97-128	88.2	649	0.3932	0.70506	0.70383	-5.9
97-90	81.8	1110	0.2133	0.70449	0.70382	-5.9

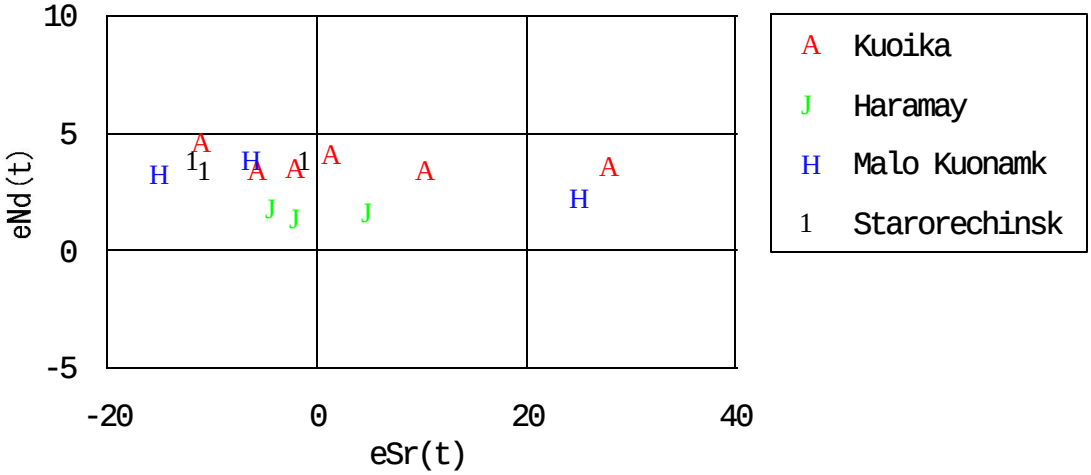

Figure 1: Initial eNd versus eSr values for kimberlites from Kuoika (square), Haramay (circle), Malo Kuonamk (triangle), and Starorechinsk (cross) kimberlite fields. Data from each kimberlite field plot parallel to abscissa with nearly the same eNd value. This indicates that Sr isotopic compositions of some kimberlite bodies were increased due to the reaction with groundwaters after the emplacement of kimberlites.

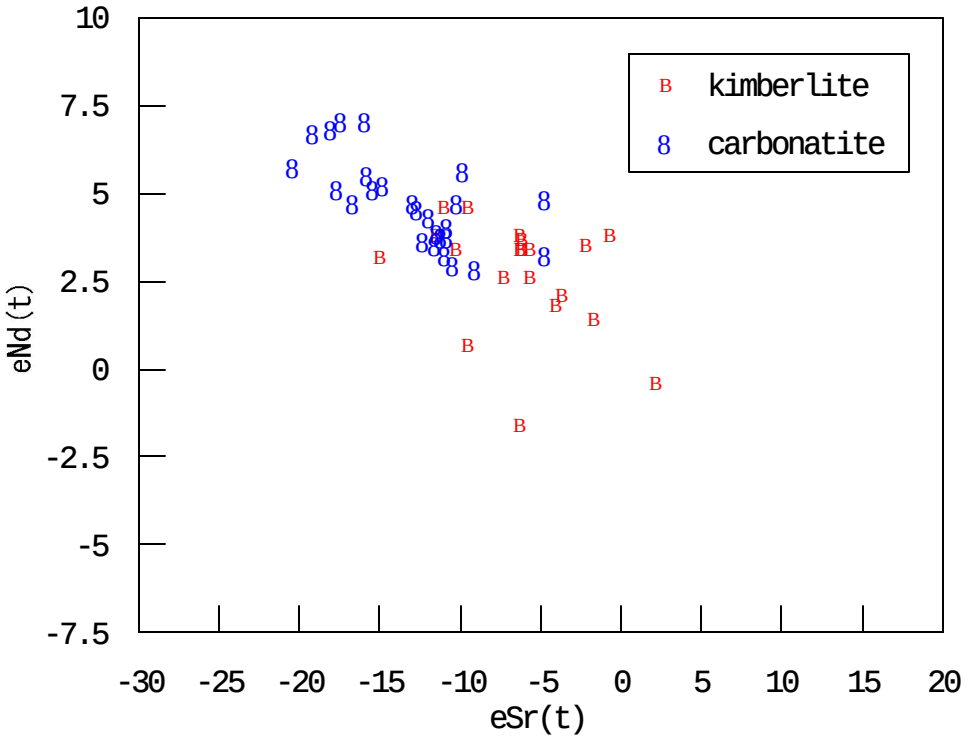

Figure 2: Initial eNd versus initial eSr values for kimberlites (square) and carbonatites (cross) from the Siberian Platform. Kimberlite samples probably underwent isotopic alteration have been excluded from the consideration. Carbonatites shown in this figure are those of Group 1 carbonatites of Morikiyo et al., (2001). All of the kimberlite samples have eNd values lower than +4.6, whereas half of the carbonatite samples (n=14) have eNd values higher than +4.6. Carbonatites have more depleted Nd and Sr isotopic signatures than kimberlites.

Table 3: Parameters used in the calculation of epsilon values

Sr	Nd
$(^{87}Sr/^{86}Sr)pr=0.7045$ $(^{87}Rb/^{86}Sr)pr=0.0827$ $ë^{87}Rb=1.42X10^{-11}/y$	$(^{143}Nd/^{144}Nd)pr=0.512638$ $(^{147}Sm/^{144}Nd)pr=0.1966$ $ë^{147}Sm=6.54X10^{-12}/y$

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