RUBIDIUM-STRONTIUM ISOTOPE GEOCHEMISTRY OF KIMBERLITES AND DEEP-SEATED XENOLITHS OF THE KHARAMAI FIELD, SIBERIAN PLATFORM

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Kimberlite rocks of the Kharamai field (south-western slope of the Anabar anteclise) are comparable in mineralogy and composition to Type 1 (Subtype 1B) kimberlites from South Africa (Smith et al., 1985). The rocks show massive and micaceous varieties. High mica contents of the rocks are due to a higher amount of differentiation of kimberlite melts; in potassium contents, the rocks are closer to Type 2 kimberlites. In massive kimberlites, increased contamination index (1.78), coupled with lower SiO_2 and MgO and higher CaO contents, suggests partial assimilation of sedimentary carbonates by melts.

Rb-Sr ages of individual kimberlite samples, determined on their groundmass (GM) using acid leaching technique, range within 135-186 Ma and predominantly within 156-177 Ma (mean 165 Ma). On a Rb-Sr diagram,kimberlite points form two isochrons:(1)age=179 ±9 Ma,initial Sr isotope ratio R_0= 0.7071 ±0.0002; (2) age=169 ±6 Ma, R_0=0.7057 ±0.0002.

Separate study of Rb and Sr concentrations in the bulk composition, silicate fraction (SF) and carbonate fraction (CF) of GM has revealed that the Kharamai kimberlites are intermediate between analogous kimberlites from the southern and northern fields of the Yakutian province and are, on the average, closer to those from the Mir and Udachnaya pipes in the ^{87}Rb content of bulk GM (7.72-33.97 mkg/g; mean 16.253 ±7.081 mkg/g) and of SF of GM (9.26-70.32 mkg/g, mean 23.1747 ±14.54 mkg/g), as well as in the ^{86}Sr content of bulk GM (24.086-213.144 mkg/g; mean 101.587 ±41.71 mkg/g) and of SF of GM (2.093-31.041 mkg/g; mean 17.987 ±6.779 mkg/g). The carbonate fraction constitutes 24.99-59.34 per cent of the bulk composition of GM and contains 37-504 mkg/g ^{86}Sr, or 40.58-98.82 percent (mean 90.42 percent) of total strontium in GM.

The initial Sr isotope ratio of most of the studied samples varies between 0.7068 and 0.7078 (mean 0.7071 ±0.0002).However, kimberlites from the Achtakh and Boloto-1 pipes show simultaneously lower-end (0.7054-0.7056) and higher-end values (0.7086-0.7107) of R_0. Nature of a number of geochemical relationships of the kimberlites suggests that they originated from two melts different in Sr isotope composition, with the "older" kimberlites (177 Ma) coming from a more lithophile-enriched source (R_0=0.7068-0.7071) than the "younger" ones (169 Ma; R_0=0.7054-0.7056). A shift in initial Sr isotope compositions towards higher values was initially due to the extent of interaction of kimberlite melts with the Cambrian carbonate wallrocks (0.7074-0.7078), and subsequently to hypergenesis processes following the consolidation of the kimberlites (0.7086-0.7107).

Garnet pyroxenites (three samples) and a spinel peridotite from xenoliths in kimberlites of the Evenki pipe are characterized by low ^{87}Rb contents (1.127-1.893 mkg/g); and, in their ^{86}Sr contents (10.595-20-121 mkg/g), they are close to SF in GM of the kimberlites. The peridotite sample (PS-92/1600) yields a Rb-Sr model age of 668 Ma and R_0 of 0.7055. For the garnet pyroxenites, the Rb-Sr mineral isochrons (rock, garnet, clinopyroxene) yield: sample S-23/1: 405 ±58 Ma, R_0=0.7040 ±0.0006; sample Sch-1/5: 440 ±21 Ma, R_0=0.7041 ±0.0002; sample b/N: 478 ±28 Ma, R_0=0.7036 ±0.0001). During emplacement of the Evenki kimberlites,Sr isotope composition of the peridotites was 0.7060, whereas that of the pyroxenites was 0.7043. In general, pyroxenites and their minerals (n=9) give a calculated Rb-Sr isochron age of 432 ±23 Ma and R_0 of 0.7039 ±0.0002 (1σ). The older ages and much lower initial Sr isotope ratios of the xenoliths compared to the kimberlites from the Evenki pipe indicate that they differ in origin and are not equilibrated in Sr isotopes.

Some inconsistencies in Rb-Sr mineral ages of the pyroxenites appear to reflect an open nature of their Rb-Sr systems. Sr isotope disequilibrium on a mineral scale is typical of all the pyroxenite samples, particularly sample b/N wherein orthopyroxene has a very high Sr isotope ratio unsupported by its low Rb/Sr ratio.

The obtained Rb-Sr ages can be interpreted as follows:

1.They reflect pre-kimberlite mantle events.

2.They are intermediate figures between ages of origin and ages of metamorphism of the xenoliths.

3.They record the "freezing" time of the Rb-Sr system of minerals when rocks moved from a higher temperature region to a lower temperature one causing the system become closed for strontium diffusion.

By calculating model Rb-Sr ages (T_{BABI}) of the rocks relative to the Earth's age, one can tentatively assess the character of fractionaton of their Rb-Sr systems during evolution, as well as the $^{87}Rb/^{86}Sr$ of their source.

For the pyroxenites, a close similarity in the calculated $^{87}Rb/^{86}Sr$ for their source (0.0817-0.0833) and in R_0 (0.7036-0.7041) suggests similar Rb-Sr systems; with this, a model Rb-Sr age of their formation is estimated at 771-924 Ma (mean 822 ± 88 Ma).Within this time period, the Rb/Sr ratio and Ro values of the source of the pyroxenites practically coincide with those of the primitive, undifferentiated mantle. Thus, the Rb-Sr mineral ages of the pyroxenites are likely to reflect the "closing" time of their Rb-Sr systems upon cooling of these lithospheric areas to relatively low temperatures. Partial re-equilibration of the isotope systems of the pyroxenites occurred during episodes of entrapment in a kimberlite melt and transportation to the surface with some Rb addition and more important Sr addition. The observed inverse relationship between Rb-Sr ages and Sr contents of the pyroxenites indicates a stronger influence of a kimberlite melt on the "younger" xenoliths.

The spinel peridotite appears to have had a more complicated history. It has a rather high initial Sr isotope composition unsupported by its Rb/Sr. It most probably originated in an enriched mantle, with higher rubidium versus strontium contents. As compared to the pyroxenites, its Sr isotope system "freezed" much earlier, due to either earlier removal from high-gradient conditions or higher position in the mantle. Some of its rubidium was probably lost upon cooling of the rocks.

Consideration of the data obtained on a " R_0-age" diagram shows that the evolution path of the kimberlites with R_0=0.7068-0.7071 coincides with that of strontium in spinel lherzolites, whereas the path of the kimberlites with R_0=0.7054-0.7056 is coincident with that of garnet pyroxenites. This makes it possible to draw analogies between possible sources of kimberlite melts and the varieties of kimberlites from the Kharamai field.

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